

**HEREDITY
AND HUMAN AFFAIRS**

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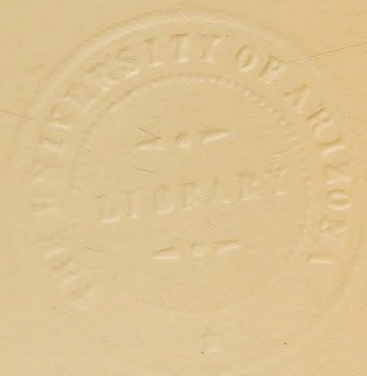
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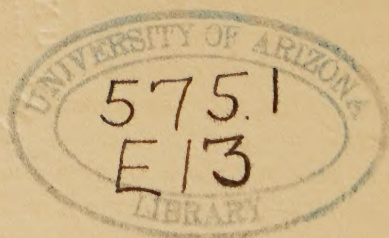


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PREFACE

GENETICS stands second to physics as the most fruitful department of science during the last quarter of a century. Physics has given us a new chemistry, a new thermodynamics, in fact a wholly new philosophy as to the nature of matter. It has made possible such marvellous mechanical inventions as the aeroplane, the cinema, and the radio. The achievements of genetics are not so spectacular, but hardly less broadly constructive. The established facts concerning variation, heredity, and development provide a new orientation in sociology.

One must be a "monstrous clever" fellow to understand the modern physics, but fortunately only a select few need to understand it. With genetics it is a different matter. Every one ought to learn the tenets of genetics, for there is a genetic aspect to nearly all the problems of society; and these are problems which are not submitted to the technical expert, but are dealt with for good or evil by all who have a voice in governmental affairs. In its detail genetics is abstruse and complicated, scarcely easier to understand than the older science, but happily the general principles are not so difficult to grasp.

The purpose of this volume is to give a simple introduction to these principles, and to indicate how an acquaintance with them may be of service in analyzing some of the more important social questions. If I have a further hope, it is that the reader may be led to undertake a more adequate study of the subject in the various admirable text-books now available, instead of obtaining his information from less trustworthy sources. I am sure that when the thoughtful members of society come to appreciate the full significance of biological determinism, and what it means to the

physical development of the individual which is the province of medicine, to the mental and moral development of the individual which is the province of education, and to human evolution which is the province of eugenics, they will wish to have a more intimate knowledge of genetic discoveries even at the cost of considerable concentration and effort. They can get one version from newspaper men and professors of journalism, from certain retired lawyers and bartenders, from preachers and social workers, who write out of the fulness of their hearts. They can get another version from the works of Morgan, of Bateson, of Conklin, of Guyer, who write out of a fulness of critical experience which has made genetics a science.

Genetic discovery, I am fain to believe, gives man the opportunity to regain his lost gift of perpetual youth—not his youth as an individual, of course, but the fast-fading youth of his race. It is a treasure, therefore, not to be abandoned to the tribe with long, silky ears. You will remember the story, which comes from the ancient Greeks, who, as men of sense, judged their kind with humorous conceit. The tale runs that Prometheus created man out of the parts of various animals held together with a little clay, and stole fire from heaven for the protection and comfort of his creature. No better in his original state than now, man immediately betrayed his creator; and the gods, delighted with his treachery, confirmed the gift of fire and also bestowed a new treasure, that of perpetual youth. Man forthwith bundled his untried bounty on the back of an ass for transport back to earth, and left the animal to his own devices. The carrier, being an animal, became thirsty; and, being an ass, exchanged his burden for a drink of water. Thus man lost his youth and became the prey of the calamities which his unbridled curiosity loosed from Pandora's vase. But he still had hope, he still had curiosity, and he still had the eternal fires of science. The combination has served him well. He is now in a position to control his fate, provided he does not

allow the latter part of the history—for this so-called fable is indubitably history—to repeat itself.

Naturally I have drawn upon the investigations of numerous authorities in special fields of genetic inquiry. I am heavily in their debt; but, being scientists and withal philosophers, I know that these gentlemen—and ladies—do not expect or desire special expressions of gratitude. One is always free to glean at will from the work of the indentured servants of truth.

In a more personal way I wish to make a grateful acknowledgment to the editor of *The Forum* for permission to use the material of Chapter I, which first appeared under the imprint of that journal; to the editor of *Scribner's Magazine* for permission to reprint portions of Chapter II and nearly the whole of Chapter V; to the authors and publishers who kindly allowed me to make certain quotations which are duly cited in the text; to my friend Doctor Conway Zirkle, who has scanned the entire manuscript with the eyes of a sympathetic critic, and who has contributed to Chapter X a genetic analysis of the work of Doctor Franz Boas on the changes in head shape found in the children of certain immigrants; and finally to my wife and to my sister, who aided with the proofs.

Boston, July, 1927.

E. M. E.

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HEREDITY
AND HUMAN AFFAIRS

CHAPTER I

SCIENCE AND THE NEW ERA OF HUMANISM

IN our most cherished beliefs, from the earliest ages to the present, there is a great deal to justify the opinion of the cynic that man is to be distinguished from the apes not by his lack of a tail but by his megalomania. Since becoming the dominant animal on the surface of this cosmic atom, he has never, until recently, had the slightest doubt concerning his supreme importance in the general scheme of things. This conviction is discoverable in every reaction, but nowhere is it revealed so clearly as in religious creeds and social folkways. One may take them as they come: Egyptians, Greeks, Teutons, Americans; the central urge is the same. Even the humble worshipper of Nature, who deified the clouds and the trees, allowed delusions of grandeur to crop out in his personal dealings with the rest of the world.

Of all creedal histories illustrating the vainglory of the species, few serve better than that of the Nordics. These doughty tribes had raised up a rough and violent crew of supernal hero-gods with whom they hoped to enjoy a post-mortem fellowship, fighting, feasting, and possibly philandering, in the great hall of Gladsheim—a faith which proved quite satisfactory as long as the promised reward was sufficiently alluring. Unfortunately, with the passing of time, customs changed. The valiant tribes of the North Sea border became urbane and civilised. They craved more seemly returns for gentlemanly conduct, a less vehement paradise where the weary might sometimes be at rest. Nothing could have fallen out better. The Hebrews had a theology precisely of the type required, based upon belief in a single god who made them the special object of his solicitude; and since it seemed probable that a single god

would be easier to placate than a whole group of gods having different attributes, our northerners forthwith gave up the old and took on the new convictions with considerable promptness and a reasonable degree of thoroughness. They figured that no god having a modicum of culture and good taste could possibly retain a Semitic tribe as his special favourite; given the opportunity, he would abrogate the earlier privileges and make them the Chosen People. And to-day the Jews retaliate by proclaiming the Nordic race a myth.

This god had existed for infinite time, and at an early period had brought into being a host of celestial spirits who made the heavens ring with continuous pæans of praise for their creator; but subsequently he seems to have had no creative urge until about 6,000 years ago. At this time, within the space of six days, he moulded the earth, designed and formed the various animals and plants, and created man.

Here and there some vagueness attaches to this procedure, but there is no vagueness about the importance of the earth or of man. The sun, the moon, and the stars were created to give light upon the earth. Man, both male and female, was created in the god's own image out of the dust of the earth, and was given dominion over the other less estimable creations. He was told to be fruitful and multiply, to replenish the earth and subdue it.

This animated statue of Yahweh was so pleasing a product that the sculptor promised to occupy himself forever after with the minutest details of its conduct. He even selected certain of the creatures to act as his amanuenses and to compile his wishes into a complete and comprehensive guide to proper behaviour. This was necessary, because man, who in some ways was lower than the angels, was in one way much higher. As a special favour, Yahweh had permitted him to choose his own line of conduct, a boon which seems to have been denied to the celestial band, although there is some difference of opinion on this matter. At any rate, each

of these images was to have a short period of earthly existence during which he must strictly obey the divine laws as thus laid down. Occasionally the rules were suspended and dispensations granted to particularly commendable individuals, but this was done only in rare instances and could not be counted upon in every case of need. The reward for exemplary behaviour was infinite pleasurable existence as a member of the heavenly choir; the punishment for wilfulness and obstinacy was a coextensive existence in a place of perpetual torment.

Yahweh was a strange god, a god of battles, a god of torture, a god unwilling to forgive his erring creatures without an oblation of blood. He connived with his favourites at trickery, thieving, and murder; he pursued those he disliked with relentless hatred. He avowed himself a just god, and dispensed injustice; he preached love, and stirred up hatred. Strangest of all, an immutable god characterised by these distressing habits, he nevertheless took on a wholly different personality some 2,000 years ago and became Jesus of Nazareth, the humble, the loving, the sympathetic Shepherd of Men.

This creed, extraordinary alike for the savagery, the ignorance, and the egotism which organised and built it up, not only has been the faith of our ancestors for numerous generations, but is believed implicitly by the majority of the white race to-day. Upon it is founded the greater part of our social system with its multitude of conventions and customs. Many of those who read this statement, with beliefs influenced by gentler ethical teachings and by more or less familiarity with science and philosophy, will deny that it is true. Nevertheless, I think that it is strictly in accordance with the facts. Proof may be found in the recent newspaper questionnaire on the subject carried on throughout the United States. The crudity of the doctrine as outlined here has been subdued by special interpretation, the savagery and injustice have been glossed over, emphasis

has been laid upon matters which are to some extent more reasonable; but, even so, the faith of the unintelligent and the unenlightened, who still make up the vast majority of this as of other generations, is substantially that which we have described. And even the enlightened and intelligent have great difficulty in divesting their minds of notions having the same general character, simply because such ideas so thoroughly pervade their habitual courses of thought that conscious rationalisation is inhibited.

Notwithstanding this situation, an avalanche of scientific discovery has brought about the possibility of emancipating mankind from the thralldom of such primitive folklore. The conception of a little geocentric universe created as a private preserve for the Hominidæ has been replaced by something infinitely more grand and glorious. We have to conceive of a universe incredibly vast, with thousands upon thousands of suns accompanied by their satellites, each moving swiftly on its course with the utmost uniformity and precision, each isolated and apparently independent, yet all parts of a harmonious whole, kept in their places by the mutual influence of one upon another. And in this complex of complexes all matter is undergoing endless change; slowly but surely there is continuous transformation, evolution. All that which we know as inorganic matter, all that which we know as life, has been built up from simple elementary substance and passes again to simple elementary substance. Thus has the earth, a minute attendant of one of the younger and less important stars, come into being. Thus has man, and all other types of life, evolved. He is an infinitesimal part of the great scheme, like all the rest; governed by natural law, like all the rest.

This is the magnificent generalisation which the combined facts of astronomy, of chemistry, of physics, of geology, of biology, have given us. This is the generalisation, accepted by every scholar, which the organised forces of stupidity and ignorance have the impertinence to call

an unsupported hypothesis, and against which they set as unquestionable truth the mythology of the ancient Hebrews. This is what empty-minded bigots have prevented being taught in two of these United States, and which they would like to prevent being taught in the other forty-six. Why? Because they are confirmed egotists, who, though they sense but dimly its implications and have no knowledge of its factual basis, are ridden by a haunting fear lest the whole thing be true. They cannot bear to think of accepting a reduced cosmic rating for their egos, of modifying their ideas of personal immortality, or of relinquishing belief in free-will. And, after all, the most illogical and ignorant individuals differ from the most intelligent and best-informed only in degree. We all have unjustifiable prejudices on sociological questions; suffrage, democracy, communism, prohibition, birth-control, the inheritance of acquired characters, and a thousand other problems are discussed not so much on a basis of evidence pertinent to the case as upon a basis of emotional reactions influenced by the *mores* learned in early youth. At luncheon not long ago I found myself sitting beside an intelligent, serious-minded woman who said she was interested in heredity, and who asked if any evidence existed tending to show hereditary differences in mental capacity. I outlined the data which have led geneticists to agree that such is indeed the case. She listened attentively, and then remarked: "But I do not accept this evidence as showing congenital differences in intelligence." Somewhat at a loss I said: "What evidence would you accept as critical proof?" Smiling a little, as if in humorous appreciation of the situation, she replied: "None."

Progress in science brings the dawn of a new era. A single century of fruitful investigation has made it impossible for thinking men to believe the theses contained in Fundamentalist doctrine. Comparatively few at present do a great deal of sustained and concentrated thinking, it is true; but the number is growing year by year; and a still greater pro-

portion is capable of drawing essentially logical conclusions if the truth is placed unreservedly before them. I do not share the fear so often expressed that the current Fundamentalist activity is the sign of a universal and rapid intellectual retrogression. The Fundamentalists are simply fighting tenaciously for a lost cause, as people so often do. Their forces undergo constant depletion with the spread of education; and the apostates do not recant. Science, on the contrary, never loses a convert. Perhaps this is the reason why the Fundamentalists are as mediæval in the violence of their denunciation of opponents as they are in the quality of their logic.

At the same time one should not be deceived into believing there are no difficulties in the present position. The change in point of view has been abrupt, and it is always difficult to adjust to sudden change. The older men of today were saturated with orthodox doctrine in their youth, and though this doctrine is now an insult to their intelligence, the early teaching has left an impression which it is almost impossible to eradicate. The old faith, variously modernised, liberalised, and stripped of its barbarities to fit our individual emotional requirements, held out certain hopes very dear to the human heart. Even eternal fires were not to be despised if one could retain personal immortality, especially as there was always a lingering confidence in final pity and redemption. The new faith, imperfectly understood, its possibilities more or less untested, has seemed to offer nothing to replace what has been lost. Psychologically, therefore, emotional souls are afloat in a rudderless boat.

In a recently issued biography of Darwin, Gamaliel Bradford¹ has painted a vivid picture of the doubts that assail the timid when they endeavour to adapt themselves to the new conceptions. One finds here a keen, even a humorous appreciation of the absurdities of the older views, a pene-

¹ Gamaliel Bradford. *Darwin*. Boston, Houghton, 1926. Quoted by permission.

trating analysis of the effect which belief in the comparative insignificance and immateriality of this life has had in retarding progress in political justice and social ethics; yet a future dominated by Truth, whatever it may happen to be, is viewed with hopeless pessimism.

Conklin, one of America's foremost biologists, predicts a new religion based upon accepted knowledge that will certainly be no worse than that of the past, and may be infinitely better. "In the past, religion has dealt largely with the individual and his relation to God; its chief concern was the salvation of individual souls and their preparation for a future life; it has been largely *egocentric*. The religion of the future must deal more and more with the salvation of society; it must be *ethnocentric*."

But, says Bradford, "I confess that I am myself perfectly, enormously *egocentric*, and these *ethno* considerations appeal to me very little. In so far as the good of the race is identified with my personal comfort and well-being, I am interested in it. But my ego cries out for God simply for itself, and if it is to be wiped out like a dewdrop in the sun, words cannot express my utter indifference to the well-being of the race, of the world, of the universe." And he brings his essay to a close with the despairing cry: "It was Darwin, the gentle, the kindly, the human, who could not bear the sight of blood, who raged against the cruelty of vivisection and slavery, who detested suffering in men or animals, it was Darwin who at least typified the rigorous logic that wrecked the universe for me and for millions of others."

Truly, as said this alleged wrecker of a phantom universe, happy in the midst of the wreckage in spite of constant ill health, "what an inexplicable frame of mind is belief!" If Bradford's attitude is typical of the other millions, a new religion is sorely needed.

Though our intense longing for personal immortality is unquestionably the chief obstacle to general acceptance of

a biophysical conception of the universe, it is difficult to believe that it is an essential either for happiness or for high ethical standards. Let us ponder the matter a little. Presumably nothing is gained by putting M. Bergeret's ironical query: "Why do men cling to the hope of an eternal after-life, when they do not know what to do with the one they have?" But is it not pertinent to ask the philosophical question: Why do those who were not here in 1850 worry because they will not be here in 1950? A common answer is: "We grant that it is illogical to think of personality having a beginning without having an ending; but having developed individual consciousness, it is inevitable that we desire to retain it; without such expectation, life is vain and hopeless." One may question whether the latter part of the reply is true. Such hopes are not inevitable; they are the result of early training, and can be eliminated with the passing of that training.

Every student of comparative religions knows that numerous peoples have believed devoutly in doctrines carrying no such ideas. Gautama taught that there are three base cravings dishonouring human life: the desire to satisfy the senses, the desire for personal immortality, and the desire for worldly prosperity. According to him, there can be no peace and happiness unless men lose themselves in something greater than themselves. And there was an echo of Gautama in the simple precepts of Christ. These two, the greatest of religious teachers, suffered the fate of all such, and had their creeds elaborated and distorted beyond recognition; but they were sufficiently in advance of their time to be in harmony with much of the philosophy characterising our modern thought, and one can hardly doubt that both would have welcomed truth whatever its implications. Are sincere followers of their teachings less happy than the rest of mankind? Perhaps there are no strict adherents of true Christian teaching left whom one may ask if they are happy, since Pauline theology has wholly

replaced the lessons of Christ; but even the sadly retrograde Buddhism of the present day marks its followers with a calmness and self-restraint almost unknown among Occidentals. Nor can it be said that our own scholars, who are so frowned upon as contemptible materialists, are less well balanced than their fellows. In spite of the fact that they have as yet no well-defined policy of constructive social effort in which to submerge the supposedly irrepressible ego-centric instinct, statistically they show a much more stable nervous organisation than the general population.

As to ethical standards, there is a very different outlook. Indifference to this brief and trivial life made the established church an abettor of every really important injustice the world has known. Charity was taught and practised as part of the Good Life by which one laid up treasure in heaven, but it was a pitifully superficial charity which left the causes of human misery untouched. Progressive movements seeking to bring about political freedom, to eliminate slavery, to encourage public education, in fact all the great reforms designed broadly to promote public welfare, found the church cold and unconcerned. The history of political and social advance from Locke, Montesquieu, and Paine to the present day is the history of rationalism. And the one reason that there is such a history to write is progress in science.

I am speaking, of course, of the Pharisaical ecclesiastics who always dominate the established churches and lay down their policies. The religious tenets of the Christian faith were not of a nature to demand a reactionary and inhumane attitude on the part of the hierarchy. Quite the contrary. Jesus was a good deal of a rationalist, unsympathetic with outworn and undesirable customs. His efforts at practical social reform were numerous, and in Kirsopp Lake's opinion he paid for his criticism of the church rulers with his life.

Many of the social panaceas offered to a sick world dur-

ing our single century of wide-spread inductive judgment have been ill-considered and impractical. A smaller number have been quack remedies, as bad as the disease they proposed to cure. But no one can deny that there has been extraordinary progress in putting the social sciences on a scientific basis, and in producing practical results. Mistakes have been made in the past and will be made in the future; but the aim of all these doctors, foolish as well as wise, is worthy. Their whole desire is to make the world a better place in which to live.

No sound criticism can be made of such an ideal, and this ideal is strictly compatible with the most advanced scientific thought. It is certainly true that this queer old world has its objectionable features. Hardships will continue under the best of schemes conceivable. We will all have our hours of pessimism. But this is not necessarily to be deplored. Hard knocks have their value, pessimism its place. The only haven of 100 per cent optimism is the lunatic asylum, as one of our sages has observed; wise men are more critical of values, more dubious of social nostrums. Yet the supposedly valid criticisms raised against what one may call the religion of science have all been instances of misunderstanding, or of half-knowledge, which is worse. They are the product of *littérateurs* who have had but a perfunctory acquaintance with biological theory, and who have been obsessed with the idea of conflict. Two of the most eminent and most influential, Tolstoi and Nietzsche, were even mentally unstable. The conclusions they drew out of their limited store of science were monstrous. And they had many imitators and followers.

Their deductions were not only unnecessary, they were unsound. It is true the two poles of life are love and hunger. If there had not been a struggle for existence, we should never have arrived; were it not for the sexual instinct, we should never have survived. There will always be struggle, there will always be love. But is this truth a cause for

horror and despair? Not at all! Those who are familiar with the works of that penetrating yet sympathetic student of sexual psychology, Havelock Ellis,¹ will recall that he finds the human mating instinct to have a value quite distinct from that which it holds for the lower orders.

The sexual impulse is not, as some have imagined, the sole root of the most massive human emotions, the most brilliant human aptitudes—of sympathy, of art, of religion. In the complex human organism, where all the parts are as many-fibred and so closely interwoven, no great manifestation can be reduced to one single source. But it largely enters into and moulds all of these emotions and aptitudes, and that by virtue of its two most peculiar characteristics: it is, in the first place, the deepest and most volcanic of human impulses, and, in the second place—unlike the only other human impulse with which it can be compared, the nutritive impulse—it can, to a large extent, be transformed into a new force capable of the strangest and most varied uses.

In like manner the survival instinct can be productive of good. In spite of what Ellis says, it also is capable of a sublimation, a transformation, corresponding closely to that of sex. Self-preservation is the oldest and strongest urge. It has caused ferocious personal struggles and vast massed conflicts. It has pitted brother against brother, and country against country. It is the basis of fraud and deception, of all sorts of knavery. But this need not be so. It will not be so if man is taught to rely upon his brains rather than his emotions a little more frequently than he has in the past. Co-operation can take the place of struggle. The welfare of the individual can be promoted, and promoted easily and smoothly, by uniting for the welfare of the race.

Nothing has been accomplished by war, or by those economic conflicts outdoing all war in brutality and malevolence, which could not have been achieved better in some other way. And now the way has been opened. Overpopulation can be avoided. Our numbers can be kept at

¹ Havelock Ellis. *Studies in the Psychology of Sex*. 6 vols. 1900-1910.

a figure where distress and misery are at the ebb, where sunshine, good cheer, and happiness are at the flood. They can be raised to the point where there is efficient production and distribution of the material comforts of life; they can be kept small enough to give each individual the opportunity to make living a real joy without a killing competition for place, small enough to allow success to crown the efforts of preventive medicine in bringing about a lower disease-rate and a lower death-rate, small enough to give every boy and girl all the education and preparation for life they are capable of assimilating, small enough to permit some leisure to cultivate science and the arts. A reasonable practice of eugenic measures, guided into proper channels by genetic knowledge, can be utilised to nullify any possible ill effects which might arise as the tyrannous rule of natural selection is gradually overridden and annulled. When man does this, then indeed will he be the captain of his fate; no longer will he be tossed about on the waves of chance by the blind forces of age-old instincts. There will be more happiness and contentment; the world will be a fitter place in which to live.

Why do I enlarge upon this subject in a manner which, it must be confessed, partakes of what Elbert Hubbard called a preachment? The reason is simple. The reign of mysticism is over, even though the mystics do not yet realise it. It can never return to power. There is ample intellectual foundation for a new confession of faith and for a new social structure. It is capable of giving us both an emotional inspiration and a practical procedure for enriching human life. The one thing lacking is a general scattering of this store of knowledge. Increase has far outrun diffusion, and diffusion must be thorough in this democratic age before there can be sound and satisfactory application.

Naturally there can be no wide-spread appreciation of all science. The field is vast, and the harvest has been abundant. The most one should expect in the case of astronomy,

geology, chemistry, and physics is a reasonable dissemination of their broad generalisations regarding the structure of the universe and the composition of matter. Biology, on the other hand, must advertise its wares far and wide. Its more important conceptions must become household knowledge. The keystone of the new social structure, the pivotal factor of advancing civilisation, the guide of the new religion, is biology; for man is an animal, and his characteristics, his requirements, his reactions, can be recorded and studied quite as carefully and precisely as those of any other animal. Biology is the Science of Life. And it is the Science of Life that must be pondered so continuously, so conscientiously, so reverently, if an Art of Living is ever to be developed.

No established fact in anthropology, anatomy, embryology, physiology, or any other of the grand divisions of the subject, can be regarded as meaningless or even superfluous in connection with the task that is set before us. Nevertheless, two outstanding beacons, two lighthouses of first magnitude, will probably do more towards steering society into safe channels than any others. I speak of psychology and of genetics, the study of the nature, function, and phenomena of the mind, and the investigation of heredity, variation, and evolution. On a solid foundation of psychology and genetics, students of social science can synthesise safely and soundly. And in due time, perhaps our aldermen, our members of Congress, our presidents, and others to whom we let subcontracts for the actual work of social construction, will become aware of their findings and will labour with more intelligence and efficiency than heretofore.

"Science," says George Moore,¹ "is a good old barn-door fowl; build her a hen-roost, and she will lay you eggs, and golden eggs. Give your money to science, for there is an evil side to every other kind of almsgiving. Science will

¹ George Moore. *Modern Painting*. Carra Ed., vol. 19, 1923, pp. 113, 114.

alleviate the wants of the world more wisely than the kindest heart that ever beat under the robe of a Sister of Mercy; the hands of science are the mercifulest in the end, and it is science that will redeem man's hope of Paradise."

CHAPTER II

HEREDITY—LATE MASTER RIDDLE OF SCIENCE

INSCRIBED on the Delphic oracle were the words "Know thyself," and this, says Cervantes, "is the most difficult lesson in the world." The familiar phrase, worn and weathered by 2,500 years of unconsidered repetition, is a good motto. None better. In spite of its venerable antiquity, I recommend it anew to the knight errant of social advancement. What opportunity exists for social progress without a knowledge of the units of our social organism? And how can man know himself if he remains in ignorance of the forces which make him what he is? For the individual is wholly and solely the product of his heritage and his experience, and unless he learns something of the limitations and the possibilities thus allotted, he can have no intimate acquaintance with himself or with his neighbour, he can neither judge with accuracy nor himself be judged. The idea of free will must become as obsolete as belief in the reward or punishment man was to obtain by exercising it. If we are to have finer and more salutary conduct, it can only be obtained by giving the individual a better hereditary endowment and a better environment in which to develop it. Genetic wisdom is the fundamental requirement in managing human affairs.

We may react against a statement which assigns to free will no part in life, we may poke fun at what some have called "Calvinistic predestination in scientific guise"; but the facts remain. Let us think a moment, before we scoffingly pass judgment. Is a feeble-minded child likely to become a scholar? Will the boy with a clubfoot win medals at the stadium? Can the individual with a cleft palate

develop into an orator of note? Of course they cannot do these things. Their heritage circumscribes their world. Is it so strange, then, that heredity should set bounds for each one of us beyond which we cannot pass?

If every one could be offered the same opportunities for health, wealth, and education, we should still have with us the sound and the diseased, the rich and the indigent, the scholar and the simpleton. One cannot make the same machines out of different materials merely by using the same factory processes. It must be frankly admitted that equal opportunity for all has never been an accomplished fact, even as an experiment. In every generation and in every country great ability has remained undiscovered and undeveloped because of unfavourable circumstances—a matter which society should take to heart. But we do not need this precise experiment to give heredity its proper value in the world's great works. The truth is that history shows little association between great opportunities and great deeds. You can keep a good man down, but it is not easy; he is very likely to forge to the front in spite of every difficulty.

The cult of *égalité*, so positively proclaimed by professional democrats and socialists, is a pose. They trust it no more than the most unswerving aristocrat. If every one were on the same dull level, the exhorters would not effervesce so violently on the subject. The doctrine roots in egotism rather than altruism. Most of us are envious of some one or other, with very good reason, and this belief serves as a means for overcompensation. B thinks he is as good as A, therefore C must be assumed to be as good as he; but privately he does not admit the corollary at all. The physical weakling persuades himself that there is an association between high-grade brains and low-grade bodies; the failure is convinced that if he had had a chance he would have been opulent and distinguished. The attitude is based upon understandable psychology, but not upon sound bi-

ology. And it is strictly a Western creed. No Oriental believes it for a moment, though he makes use of it, for reasons similar to our own, when in contact with the West. Was it not a Wise Man of the East who said: "Do men gather grapes of thorns, or figs of thistles?"

Yet modern deterministic philosophy which gives such a new outlook on life is the homologue of predestination only in part. There is in it no room for fatalism. There is only a more sympathetic understanding of each man's problems, an appreciation of the truth that different individuals have distinct difficulties to face, that a mole-hill to one becomes a mountain to another. It is not fatalism to see that responsibility varies among the units of our population, that an Einsteinian yardstick must be used to measure social conduct. It is not fatalism to place upon society as a whole the burden of accountability that is its just due. If social order makes certain requirements of the individual, the exigencies of the case demand that through just government, adequate teaching, and scientific economic adjustment the individual shall be given the opportunity to develop into as fit a social being as his heredity permits.

What genetics tells us is that heredity allots to each certain possibilities; whether these possibilities are fulfilled or not depends wholly upon circumstances. The fundamental requirement for a sound and healthy body is a proper ancestry; but if one wishes to make the best of the bargain after having had his ancestors chosen for him, he should look to his food, his rest, his recreation, and his habits. A child cannot become great unless he has capacity in his make-up, but he will not become great under any circumstances if his talents are kept rolled up in the proverbial napkin. And so it is with moral customs. Intelligence varies; some can be reasoned with, some can be led, some, unfortunately, must be driven. Society has a heavy responsibility, therefore; if its customs are not justifiable to a rational mind, the intelligent cannot be persuaded to ac-

cept them, and the unintelligent ought not to be driven to conform to them.

These may seem like dogmatic statements, but they are well within the facts. A great deal is known to-day concerning the respective rôles of heredity and environment, and of the precise way in which the parts are played. Until recently heredity was regarded as inscrutable—the master riddle of science. Twenty-five years ago it was a synonym for mystery, and a text for discourses on the unknowable. Not so to-day. In a quarter of a century laws of heredity have been formulated as definite and precise as those of physics and chemistry. The mechanics of the two tiny cells which unite to hand the spark of life from generation to generation in our world of animals and plants have been analysed with a clear-cut accuracy hardly to have been expected when one is dealing with such entangled phenomena. Individuals with diverse heredities have been grown to maturity and their life histories carefully studied in environments as similar as human ingenuity can make them. Individuals with identical heredities, parts of the same personality, as it were, have been reared in environments so extremely different that the very threshold between death and life was reached. Many minds and many hands have been planning and executing intricate experiments designed to answer the question, What makes us what we are? And they have had a marvellous success.

Without overstepping fact, one may say that genetics, the science of descent, has been the most profitable branch of twentieth-century biology. The term profitable refers primarily to the world's intellectual advancement and not to financial gain, but even with the latter meaning in mind one can make some rather broad claims legitimately.

Genetics has made possible better strains of live stock. Meat production is more rapid. Food utilisation is more efficient. Disease is less to be feared because of resistant stocks. Milk yields are increasing steadily. Both sheep

and goats produce longer and stronger wool, or finer and more glossy wool, according to the heritage allotted to them. Man sifts out the undesirable characters of his four-footed servants; he spies out, isolates, combines, and strengthens those which are useful. He cannot create new raw material for his purpose, such a task being on a parity with creating new mountains of ore; but just as he takes the ores he finds and with them creates new mechanical engines, so can he use every desirable new character as material from which to create new breeds suitable to his varied purposes.

Among plants there is the same story. New types specialised for different uses are constantly brought into being. Novel varieties appear in increasing numbers year by year, and though the great majority of them are probably little better than the older types they are designed to replace, here and there a strain stands out whose inherent merits make it worth millions. In fact, when one lists and studies the chief varieties of farm crops now grown, he finds scarcely a single one which was known to the world 50 years ago, so rapid has been this man-made evolution of the vegetable kingdom.

Such progress is very interesting and important, no doubt. A dinner, a pair of shoes, and an overcoat are matters of moment to the shivering wretch at the *rôtisserie* window; and those who make them easier to obtain deserve our gratitude in lieu of the royalties we do not pay on their discoveries. But no biologist likes to feel that the true goal of genetic work lies in adding loaves of bread and bales of wool to the world's supply. He fervently hopes to aid those functions of mankind which rate somewhat higher than alimentation, realising as he does that there is some truth in the gibe of Anatole France, that food ingestion is a humiliating process which might well have been relegated to a larval stage after the manner of the insects.

These are the phases of genetics to be treated in this

volume. It is not to be a technical treatise, packed from beginning to end with genetic facts and principles; rather it is designed as a discussion, or exposition if one prefers, of the genetic philosophy of life. Some readers, no doubt, will feel that it should be called a eugenic work; but this is true only if one accepts the interpretation of Carr-Saunders¹ that "the science of eugenics is the study of the part played by inheritance in human affairs." Galton's final definition of the word he coined implies the application of knowledge as a means of racial improvement. His proposals, as became a scientist of whom the world may justly be proud, were always noble and dignified. As he stated them, they were neither absurd nor impracticable. To avoid applying them in some measure is to render racial improvement impossible. This conclusion follows as inexorably as the conclusion that three plus two is five, for it is precisely the same type of mathematical inference. No impertinent arguments by ignoramuses, no display of shallow wit by simpletons will change the deduction in the slightest. But here we are not concerned with practical means for racial improvement. What we have in mind to consider is the new orientation that genetics gives to some of the problems of social science, which are, of course, the problems of every-day life.

Are you a lawyer? Genetics gives you a better conception of where human responsibility begins—and ends. Are you a minister? It shows how variable are the needs of spirit and of body among different individuals. Are you a physician? It enlarges your opportunities for successful treatment of all the various human ills, for the hereditary endowment of each one of us looms large in every pathological condition. If you are none of these, if you are one of the millions of citizens whose vocations seem to imply about as much usefulness for this type of biological knowledge as for training in the integral calculus, do not forget that

¹ A. M. Carr-Saunders. *Eugenics*. London, Williams & Norgate, 1926.

you live in a democracy and have a vote. You will be called upon time and again to make a personal decision as to the merits or demerits of various proposals relating to marriage and divorce, to education, to immigration, to conditions of living which affect the public health, and to various other matters which concern the welfare of this and of future generations. And, as Wiggam says: "One can approach very few of such problems intelligently without some knowledge of heredity, because he is then in total ignorance of one of the largest forces that enter every moment into human life, human character, and social destiny."

I am convinced that genetics will be of greatest service along just such lines. The establishment of the theory of evolution in 1859 was followed by no industrial upheavals comparable to those attending the invention of the steam-engine or the discovery of the Bessemer process. It had no utilitarian application whatever; yet it influenced the entire current of human thought, and influenced it more profoundly than any other scientific decision. It is in this manner that the generalised findings of genetics will have their most pertinent application to questions of social welfare. The problems will stand out sharply defined, clearly differentiated. We will approach them with a new confidence born of saner thinking. But it is doubtful whether the concrete knowledge gained by genetic experimentation will often provide a definite, practical solution to the difficulties which beset our complex society at every turn.

The very nature of the heredity mechanism compels this conclusion. Essentially a simple process, it results in complex permutations and combinations of potentialities, and these in turn may be disturbed by varying conditions not easily controlled or evaluated. For this reason it is unlikely that a time will ever come when even the most enlightened scientist can predict with accuracy the result of each and every human mating. Certainly legal restrictions to marriage will never be numerous, and will be confined to those

cases where it is a foregone conclusion that seriously abnormal children will result. No court will ever sit where the judges will sentence choice specimens of humanity to frequent parenthood and condemn the rest to sterility; though the outcome of such an experiment would undoubtedly be interesting. But the day will not be long when certain physicians will be genetic specialists, and prospective brides and bridegrooms will go voluntarily to them for advice regarding the possible outcome of the proposed marriage. Even now one has the opportunity to learn much regarding his or her genetic possibilities by interpreting their ancestral histories in modern genetic terms. One can predict absolutely whether a particular union will or will not produce many of the various dominant abnormalities which are only too common in the human race. One can also predict with relative accuracy—that is to say, one can calculate the chances for and against—whether this same union will produce mental and physical defectives of the recessive type, the type which may lie hidden for a series of generations. Such information is useful, and more and more people will come to use it for the sake of their own happiness. The good of the race will be promoted thereby, not because race betterment will be one of the primary concerns of the individual, but because it will be a by-product of a custom followed for the personal satisfaction that it brings. But the great humanistic value of genetic progress lies rather in its influence upon broad social policies designed to produce the greatest good for the greatest number. Heredity is one of those phenomena that can usually be dealt with more easily, and often more precisely, by considering averages only. In this it is like life insurance, where calculations which give very accurate results when large numbers are concerned are relatively useless for individual cases.

A very distinguished biologist said recently, the mechanical problem of heredity has been solved. He did not

mean by this somewhat enthusiastic statement that no more ground remains untilled in this extremely fertile field, that no more genetic principles remain to be discovered. On the contrary, he would freely admit the existence of great gaps in our knowledge. What he had in mind, if I understand him correctly, was that the explorations of the past quarter-century are sufficiently extensive for us to know in a general way what must be found later. The observable processes of germ-cell differentiation, growth, and maturation have been described minutely for thousands of organisms. The carriers of the hereditary factors from which the organism is built have been discovered and their behaviour noted. Something is known of the size of these factors and of their exact location within the cell-organs which provide them with a home. Thousands of characters have been traced from generation to generation and their distribution correlated with the distribution of particular germ-cells that were marked by the possession of peculiar characteristics. The analysis of such results has shown that heredity is ruled by laws which can be expressed definitely and precisely. These laws give us the solution of the mechanical problem of heredity, just as the discoveries of John Dalton a century ago gave us the solution of the mechanical problem of chemistry. No matter how much elaboration of these two sciences takes place in the future it will be but the ornamentation of a structure the framework of which has already been solidly reared.

Naturally, a living, progressive subject like genetics, having numerous ramifications capable of affecting thought in every department of applied sociology, has attracted workers of varied capacity. In purely theoretical genetics this does not much matter. Time has a way of preserving inspired thinking and of consigning absurdity to oblivion. But, unfortunately, a volunteer army of emotional gentry has been on the alert for anything new and startling that could be put to use along social-service lines. And, still

more unfortunately, these valiant soldiers of social service show a positive genius for the perverse. Let any rattle-brain calling himself a student of heredity babble forth some sappy imbecility, it is seized upon and trumpeted around in endless chorus as the salvation of society. Somehow the truth is never sufficiently titillating to be interesting. This is bad and might form an excuse for writing any number of books, but there is worse. We also have numerous incompetent wowers who pass successively from copy boy to reporter to interpreter to critic with great facility and speed. All biology is subject to this sort of thing, but genetics is particularly vulnerable because there the relationship of our vain little two-legged mammals with the rest of creation is especially well shown.

By the efforts of this last group biology has been pretty well sovietised. The proletariat has been prevented from dallying with chemistry and mathematics through inability to learn their language, but in those branches of biology where man may be accounted subject material, subdemocracy has become pompous and powerful. Thus far no Lenin has arisen, though perhaps this will come in time. Genius for such leadership is rare, and Bryan, Massee, and Brisbane have not quite been able to make the grade, in spite of the fact that their pronouncements upon biological problems having sociological bearings are reverently accepted by millions who never heard of Bateson or Morgan, Ward or Sumner. It has been assumed and taught that observation, experiment, and inductive logic are the tools of progress, that science advances in a slow and orderly manner from fact to fact until from a treasure-house of such ores may be forged a master-key with which to unlock the gate to a new uncharted region. But this idea may be only a phantasmagoria, or at best a folkway without rational justification. Who knows but that M. Bergson is right, and that reason is a less trustworthy master than instinct. A graduate student in one of our larger universities when asked

recently why he had changed his field from biology to philosophy, replied: "Well, I found that there was so much to be learned in biology that I had no time left to think, so I took up philosophy, where there was nothing to be learned, and I had all my time to think." One has a certain sympathy with this point of view.

It is generally supposed that the attitude of the average man towards biology and the biologist is a simple indifference, or at most a rather natural scepticism. It is more than this; it is an emotional reaction proportional to the shock received in the contact. People can bear the presence of a dogmatic mathematician or geologist with equanimity. A problem in differential equations or a theory concerning the age of the Permian leaves them cold. They accept calmly whatever they are told, manifesting only that show of contempt which fear of the unknown always arouses as an inferiority compensative. Let a geneticist approach, however, and the flood-gates of emotionalism are opened wide.

The geneticist's business in life is to study variation, heredity, and evolution. He seeks to chart the facts, to determine the cycles, to formulate the laws of genesis, of change, of descent. To him man is simply another animal which he can study quite as well as a rabbit or a guinea-pig, a species, so far as he can discover, which obeys the same physiological laws as other species. The proletarian will have none of such nonsense. His egocentric urge reacts against it. He wants to look upon man as something above and apart from the rest of creation, a clay pot, perhaps, but one formed and quickened by the Creator to stand as a unique masterpiece.

At one time I felt that this repugnance towards accepting well-demonstrated facts which imply genetic relationship with lower organisms would fade away under the light of increasing knowledge just as has the food taboo and the touch taboo. But I may have been overoptimistic, at least as

to the time required. By no means all of our fellow citizens, even many who have received more than the average scholastic training, accept the well-demonstrated conclusions of medical science; and here they have an opportunity to obtain direct immediate personal profit by their approval. Will they, then, ever receive quietly the teachings of a science which asks them to believe that their own heads show congenital differences that are transmitted by a mechanism essentially the same as the one by which the differences between cabbage heads are transmitted, or to give up their faith in the comforting theory that acquirements of education are handed out to each generation like cumulative preferred dividends? I fear it will be a slow process. Emotion and instinct are older, stronger, and more firmly implanted in the human race than reason.

Soviet rule on these questions is rather firmly intrenched. In addition to the absurd effusions of fundamentalists and the preposterous emanations of venal editors, one finds an extraordinary amount of extravagant propaganda issuing from platform and press, sponsored by both amateurs and professionals who are by no means insincere. These are the messiahs with whose delusions it is most difficult to deal. Their emotions lead them to preconceptions of what the rules of the universe ought to be, they set forth their beliefs with considerable ability, and are soon quoted as authorities by a flock of respectable club-women of both sexes in whom responsive chords have been struck by the views expressed.

The ranks of the amateurs and dilettantes are rather full just at present, for they seem to be recruited in greatest numbers during times of prosperity. People arrive at such an age and degree of opulence that it is no longer necessary or desirable to keep the office open for long hours, and they find time hanging heavily on their hands. To relieve this tedium they become interested in biology. By this I do not mean that they immerse themselves in the lore of the or-

ganic world until they have learned its alphabet, and from thence pass by weary labour through the grammar and up to the higher principles. On the contrary, with the confidence born of success in other fields, they pass at once to the higher principles. There they find matters which are distasteful. An organic world ruled by the laws which biologists have formulated is one in which Utopianism is restricted; these social theorists, therefore, seek to abrogate such measures by the charm of their own weird logic.

I rather believe that the dilettante has the greatest direct influence in spreading abroad the current farrago of vagaries and inconsistencies on the subject of heredity. He uses the vernacular more readily, and there are more of him. But the professional student himself is not always proof against the folk-lore he has imbibed in early youth. He also strays from the straight and narrow path of science and goes in pursuit of some unsubstantial ectoplasm. I have on my desk a recent volume of essays on the ancient question as to whether heredity or environment has had the greatest influence in bringing about the differences among existent organisms. It is written by a very eminent investigator. Seeing it, a distinguished English biologist who was a recent visitor, exclaimed: "What a pernicious book this is!" What called forth this mild opinion on the part of the English scientist was the erroneous impression conveyed, through some peculiarity of the style, by sentences which for the most part are biologically correct. The reader gains the idea that the term heredity is merely a philosophical concept like the ether of the physicist, and that the only important consideration is the condition under which development takes place. He comes to feel, vaguely but firmly, that there are no limits whatever to the variations which can be produced by slight changes in the surrounding physical and intellectual media, that present-day impotence is merely lack of knowledge. Later a feeble-

mind child born with a cleft palate and a clubfoot will be given three pills of various colours to correct his three deficiencies, and all will be well. A clutch of duck eggs will be hatchable into reasonably well-marked chicks by any good hen as soon as we find out how to eliminate or to counteract the duck environment. Of course the author doesn't quite say these things, but there will be few readers who will not be prepared to swear that he did say them by the time they have reached the end of the volume. It is hypnotic in its conveyance of what is wrong. The writer ought to buy a farm and see for himself that he still obtains Baldwin apples and Concord grapes no matter what agronomical innovations he uses in their cultivation.

These are the things which make one feel how necessary it is to have a constantly wider diffusion of genetic knowledge. The efforts of these little King Canutes will not prevail, but the spread of truth is not quite so regular or so timely as tidal flow.

In the meantime let us be charitable to the occasional biologist who writes as if he were the spiritual descendant of a Congo witch-doctor, even as we must be charitable to those who have not had his advantages. In a sense, the lot of the biologist, like that of the policeman, is not a happy one. From the time when Adam began to name the animals, as duly recorded in the second chapter of Genesis, down to the present generation, the greater part of all biological work has been historical and descriptive. Inductive logic pushed to the bitter end and applied is a new thing to him. He is cautious; which is right and proper. The duty of doubt, as Haldane calls it, is indeed a serious scientific obligation. But with the biologist, as with others, what is sometimes thought to be judicious caution turns out to be the arrogant distrust which stupidity adopts as a defense reaction against a new conception. And the reason is simple. The physicist, who has been utilising abstract concepts and exact logic since the time of Hipparchus, has

been somewhat inclined to patronise the biologist because the latter has occupied his mind hitherto with percepts, or imagery familiar to the senses, to which he could cling with a naïve faith in their reality. But the physicist is not nearly so tough-minded as he professes to be. He is merely fortunate in being able to segregate his activities. He can do sound scientific work requiring the highest type of objective reasoning, and at the close of his working-day lock up his professional personality in his laboratory, don a different ego with his dinner-coat, and wander forth to dabble with theological dogma or attend Madame Deludo's séances. The biologist has no such advantages. He is bound up with the problems of life at all times. He is psychiatrist to this lunatic asylum of the universe, and is familiar with the crude absurdities with which man likes to deceive himself, including even the reason why the physicist likes to titillate his religious emotions during his idle hours. Thus it is difficult for him to find an emotional outlet of his own unless he abandons the proved tools of mechanism with which he has delved successfully into the unknown and goes in for entelechies, élan vitales, or other untestable figments of the imagination.

The result is that the intellect and the emotions of the biologist are forever embroiled. His early training, like the training of other men, makes him hope against hope that his old heritage of beliefs is true, that environment is all-powerful, that free will prevails, that man is created in the image of God and is only a little lower than the angels. And he keeps on, a pathetic figure, proving that all the old folkways are myths, in spite of his desires and hopes. He does all this; but the conflict wearies him and makes him slow, slow in accepting his own facts, and slower still in pushing them to their logical end. I can see no other explanation for the dozens of recent sociological biologies in which the writers have started bravely to build a scientific edifice to house man's beliefs, but have finished by decorating it with

so many saintly old legends that it looked like a cathedral after all.

If this is the biologist, let us have patience with those who are unfamiliar with his work.

CHAPTER III

THE MACHINERY OF HEREDITY

THOUGH the chief purpose of this book is to consider the part played by heredity in human affairs rather than to compile a technical account of genetic research, it will none the less be necessary to sketch broadly some of the more important discoveries which have led to the current view. A philosophy lacking a factual basis is worse than no philosophy at all; and little progress has been made, since Alexander, in devising a royal road to learning.

I have always been rather fascinated by speculations as to what the ancients thought about heredity; not the savage tribes who, almost to our own era, could see no connection between the act of mating and reproduction, but the progressive ancient races who left so many beautiful records of their skill in the arts. The carefully finished bas-reliefs of Egypt, of Babylonia, of Chaldea, show strains of horses and breeds of cattle almost as fine as those of the present day. Every important domestic animal and cultivated plant was, in fact, taken from the wild and improved almost beyond recognition long before the dawn of history. And modern investigation tends to show that nearly every one of these products of agriculture and husbandry arose through the hybridisation, either accidental or designed, of two or more species.

How did they do it? Frankly, we don't know. Doubtless many, many centuries have elapsed since some fond mother first made the discovery that the newcomer had his father's eyes and his uncle's nose combined with various anatomical features resembling those on her own side of the family. And the Greeks and the Romans have left us the information that breeds could be improved by judicious

crossing and ruthlessly strict selection. I am inclined to believe, however, that their knowledge stopped at just this point. Certainly Jacob's little scheme¹ for increasing the proportion of the ring-straked and spotted cattle that were to be his hire for tending the flocks, by leading his charges among white-striped poplar and chestnut rods, was not sound biology.

A fair reason for assuming that exact information on heredity was rather scanty in the olden days—though perhaps it is somewhat arrogant to say so—is the fact that we knew no more ourselves until the beginning of the twentieth century. In the standard text-book of 1899² we find these words: "In spite of all the microscope has revealed, we have not yet penetrated the mystery, and inheritance and development still remain in their fundamental aspects as great a riddle as they were to the Greeks." What a different story to tell to-day!

The visitor to the genetic laboratory, wishing to appear sophisticated, often says, "Oh! you are studying the Mendelian Law," a remark which wearies the professional host more than a week of hard labour. With as much justice one might ask the chemist if he is studying the Daltonic hypothesis or the physician if he is applying Galen's rules. Yet there is this to be said: the beginning of the study of heredity as an exact science does date from the first real appreciation of Mendel's experiments on the garden pea carried out in the tiny monastery garden of the Moravian town called Brunn; and this was only a little over a quarter-century ago.³

Genetics was born and christened because of Gregor

¹ Genesis 30: 31-43.

² E. B. Wilson. *The Cell in Development and Heredity*. New York, Macmillan, 2d Ed., 1899.

³ Mendel's account of his experiments was published in the *Verh. naturf. Ver. in Brunn, Abhandlungen*, IV, 1865, which appeared in 1866. It was overlooked by biologists until advertised to the world by DeVries, Correns, and Von Tschermak independently in 1900 and 1901.

Mendel, not because he was such an intellectual giant he could analyse and codify the complex results which had baffled his predecessors in hybridisation work, but because he had the really brilliant idea of simplifying his experiments to the point where he was dealing with only one or two variables at a time. Where heretofore botanists had crossed plants differing by hundreds of characters and had been bewildered at the apparent chaos of their data, Mendel used varieties which differed by a single striking character. This lone character he followed through generation after generation with the carefulness of a master workman, obtaining results so simple that he was able to give them their correct interpretation. Only when he was satisfied that he knew what happened when one character was under consideration did he try to steer his way through the maze of complications produced when varieties differing by two or three characters were used.

Mendel was not really a biologist, though he investigated the heredity of both plants and animals. Biology was one of the numerous avocations of his active life, like playing chess, organising fire-brigades, running banks, and fighting government taxes. By training he was a physicist, and brought into his work the attitude of mind and the quantitative method of study which had been in use for some time by physicists and astronomers, and which was just coming to be used more widely by chemists. It was an unknown procedure in biology, though it fulfilled the essential requirements of scientific research better than anything used before; and it came to biology at a time when those who were endeavouring to investigate inheritance by means of hybridisation were unprepared for their task, and 30 years before the results of the slower-going microscopical method had progressed far enough to permit the formulation of a well-rounded hypothesis near enough to the truth to make it possible to outline the essential points to be verified and to draw up a workable plan for testing them.

Mendel published his chief work in 1866. It was a model paper, for he introduced a new laboratory method, controlled all the extraneous variables controllable, determined the mathematical relationship between the phenomena studied, interpreted his data with shorthand formulæ useful in further work, and devised an adequate hypothesis to explain his results. Yet his paper remained with uncut pages for 35 years. To cheer his own spirits he often exclaimed: "Meine Zeit wird schon kommen." Unfortunately, his time did not come until 16 years after his death. He suffered the fate of those who anticipate the progress of their age.

We have passed far down the road since then, but on looking backward we see in Mendel's work merely the first clearly carved mile-stone and not the beginning of the way. The study of a multitude of carefully controlled matings among the most varied groups of both animals and plants has pointed to a single type of cell-mechanics as the basic feature of heredity. It is the same for man and monkeys, for mosquitoes and melons. Sexually reproducing animals and plants, whatever their kind, wherever their habitat, varied as may be their manner of living, behave in the same way as regards inheritance. The controlling agents of heredity are the cell-organs known as chromosomes. The universe of genetic affairs is the universe of activity of bodies so small that one must magnify them some 1200 times to be able to see them at all. But when one does follow their cyclical history through high-powered lenses, he finds their behaviour as regular as the revolution of the planets. And what they do is what controlling agents of heredity ought to do as judged by the results from thousands of controlled matings in the breeding-pen and garden.

Of the comings and goings of these little heredity machines we knew a great deal long before Mendel's time, but we had to wait until long after his time to learn the connection between the phenomena. The growth of science is so continuous our attention is attracted only by a spectacular

change, which, like the bursting of a chrysalis, is merely the final crisis in a long series of preceding events. Mendel's paper was an epoch-making production; its influence was great; but we must not overlook those who wrote the prefaces and prologues.

Perhaps it is a slight exaggeration to boast that our knowledge of the building-blocks of animals and plants is old. Relatively speaking, it is quite recent. Men now living had to be content with an early schooling that did not give them the slightest idea of the way in which living things are made. Not until 1839 did Schleiden and Schwann tell a bewildered world that the structural unit of all organisms is the cell. Not until 1858 did Virchow prove that all cells come from the division of pre-existing cells. And even then little was known of what took place and why within this cosmos of the microscope, though discoveries came fast during the next few years.

We cannot define life. We cannot define electricity or energy, or any other of the strictly fundamental phenomena with which we come in contact. We know only that all the living, from tiny micro-organisms to monsters like the whales, are composed of cells. The simpler plants and animals are one-celled. The higher plants and animals are combinations of many cells which, though specialised in different ways, function together so smoothly that they form a coördinated harmonious whole. The cell then must be examined to find out what we can of life, and when we do this we learn that four things serve to distinguish the living from the non-living:

Cells contain protoplasm, the material basis of life, a collection of substances so complex the chemist has not the slightest conception of their organisation, except that a relatively few ordinary elements like carbon, hydrogen, oxygen, phosphorus, and sulphur are concerned. They are able to disintegrate food substances and to transform them into the particular kind and quality they require. They are able to

reproduce. And, finally, they are able to receive and to respond to stimuli. When a protoplasmic structure can do these things, we say it is alive.

What then is death, the passing of that which was alive? Death is the price exacted in return for a life worth living, a complex body, consciousness, mind. The little one-celled animalculæ do not die. They grow and divide, grow and divide, and so on and on forever, if they find food and warmth and moisture. Even the individual cells of our own bodies are potentially immortal. The various tissues can be kept growing in artificial cultures month after month, year after year; but what a life, cell-division in a glass jar! Natural death occurs normally and necessarily only in a body composed of many cells, simply because the business of living finally slows down and clogs the life-machine with the poisonous waste produced by its own activity.¹

All cells can grow, all cells can reproduce themselves, all cells can show irritability. But Mother Nature was a great experimenter. She liked to solve a given problem in all manner of ways. And thus it comes about that various plants and animals react to stimuli quite differently. It may even be said that the higher the organism the more numerous the stimuli to which it will react. If you react to Beethoven, Irving Berlin, Raphael, Rembrandt, and Bud Fisher, to mention only a few possibilities, you are presumably a higher organism than the plumber's assistant whose chief reactions are to pretty girls and corned beef and cabbage. The reverse is true of metabolism. Plants can make use of inorganic materials, while animals are limited in their food possibilities to materials already manufactured into usable substances by other types of life. Reproduction is in this respect like metabolism rather than irritability. The lower organisms have more ways of producing their kind than those which are built upon a higher and more complicated plan. The meek and lowly of the organic world can repro-

¹ Cf. E. M. East. *Mankind at the Crossroads*. New York, Scribners, 1923.

duce by numerous types of fission and budding, even if they have well-developed sexual methods of assuring a numerous progeny. The warm-blooded animals forming the aristocracy of the earth, on the other hand, have found sex quite a satisfactory invention, and have given up the more primitive means of providing for survival.

Sexual reproduction is the most successful means of generation for the simple reason that it is a perfect method for furnishing grain to the sieve of natural selection by combining hereditary variation in every possible manner. In spite of the doubts and misgivings of confirmed misogynists, Nature never invented a process that so well accomplished the purpose in view. And the thing lowering one's opinion of man as the ruler of creation is the fact that in all its essentials human reproduction is similar in type to what is found among the lower animals and even the plants.

Sexual reproduction is the formation of a new organism by the union of two cells. To these little bodies is given the task of carrying life from one generation to the next. We do not know how the process started or why; but we do know that it must have speeded up the evolutionary process to an extraordinary degree. Without sexual reproduction, any variation appearing within a species had to prove its worth as it stood. In whatever combination of characters it was found, that combination had to stand or fall on its own merits. But if a variant appeared in a sexually reproducing organism, the new character could be recombined with other characters of other individuals, thus giving it a much greater opportunity of finding an association of characters which would give it survival value.

Sex appeared early in the course of evolution. At first, the two sex-cells were to all appearances alike. In somewhat higher types one cell grew larger through the storing of food materials and became the egg; while the other cell remained small, acquired the ability to move more rapidly, and became the sperm. At first, any of the body-cells could

become an egg or a sperm; later, special organs were developed for the purpose of producing them. In simpler types the young organisms had to shift for themselves; in all higher forms, the flowering plants in the vegetable kingdom and the mammals in the animal kingdom, provision was made to protect the helpless young within the body of the mother until they develop to a stage which allows them to go their own way.

To the casual student taking a hurried view of botany and zoölogy, it might appear that the machinery of sexual reproduction is extremely variable. In a general way, this is true. Almost every conceivable method for insuring continuation of the species has been tried. Hardly a single family in either kingdom but has come into possession of some peculiar modification of the process. Yet, in another sense, Nature has been ultraconservative. The mode by which hereditary characters are passed along is essentially the same in every great group. The theme remains unchanged; only the renderings are different.

The cardinal truth of this statement becomes obvious if one examines any series of sex variations with the object of comparing their influence on the end result. Among animals wide-spread distribution of large-size eggs and small-size sperms is a striking fact. In the human being the egg is about as large as the head of an ordinary pin, the sperm is microscopic; in the ostrich the egg weighs over a pound, the sperm is again microscopic. What is the meaning of such a divergence in size among the sex-cells? Does the female have a greater influence on the offspring than the male? Is there a matriarchate in genetics as there was in ancient Egypt? No. The egg became bulky to provide the young embryo with nutriment, the sperm remained small and active to insure fertilisation. Thousands of experiments have shown that the tiny sperm transmits as many characters and impresses them as firmly on the offspring as does the huge egg. We must search for the true

physical basis of heredity, therefore, in some cell component possessed by egg and sperm in equal amounts. Such a cell structure is the nucleus.

The spherical membranous bag called the nucleus, which is about the same size in both the egg-cells and the sperm-cells of a given species, is the vehicle for the transmission of hereditary characters. For this reason it has been an object of special interest to investigators for more than a generation. As the microcosmos of life, [bustling with activity, it is naturally much too complex a system for them to have uncovered many of the secrets stored within its walls; but they have learned one fact which is of supreme importance to genetics.

The essential part of the nucleus is the chromatin, a substance so called because it stains easily with aniline dyes. The chromatin goes through numerous incarnations and evolutions during the life history of a cell. It elongates, it contracts; it forms threads, it forms networks; it is sometimes tenuous, it is sometimes substantial; but at a certain point in the drama it always fragments into bodies known as chromosomes, having a definite number, size, and shape for each species. And this is an important process, for the chromosomes have been found to be the functionaries who direct the nuclear activities, both for body-growth and for reproduction. When a cell is ready to divide, each entity of the cohort of chromosomes takes up a definite position within the nucleus and splits longitudinally into two parts, thus giving the two daughter cells the same number of chromosomes possessed by the parental unit.

Since the cells of each living species are characterised by a particular number of these bodies, and since every new individual, in the ordinary course of events, is produced by the union of two cells, it is clear that unless some provision were made for reducing chromosome numbers, there would soon be nothing but chromosomes in the world. In fact, Weismann, the great German zoölogist, who was the first to

appreciate the importance of the chromosomes, predicted, long before the process was discovered, that such a reduction division is both a physical and logical necessity.

What actually takes place is this: When the germ-cells—eggs or sperms—are formed, the chromosomes line up in pairs, and only one of each pair passes to a daughter cell. One member, and only one member of each pair—it is a matter of mere chance which—goes to take up residence in each of the new domiciles. Perhaps they draw straws, who knows? At any rate, in species where the chromosomes differ among themselves in size and shape, one can actually see that there is a pair of each type in the body-cells and the immature germ-cells, and that the mature germ-cells possess but one complete set. The fertilised egg, which becomes the new organism, is therefore a machine with a double quantity of parts.

It is not difficult to see in this arrangement a complete basis for a theory of heredity. Assume in the first place that each chromosome is comparable to a string of freight-cars loaded with mysterious substances which determine the various characters possessed by the individual. The organism, then, has at its disposal two complete sets of these determiners, one of which has been received from the father and one from the mother. When this creature, whatever it may be, becomes an adult and produces eggs or sperms, they will have only one complete set of these trains freighted with character-determiners. Any particular egg or sperm will possess one representative of the first pair of trains, and it will be a matter of chance whether it came from the father or from the mother; similarly, this same germ-cell will have a representative of the second train, which also may have originated in either father or mother; and so on through the whole series. Thus, there is a definite, orderly means by which characters pass from one generation to another, and, generally speaking, this process is one by which any given germ-cell receives one, and only one character-determiner

from pairs of such determiners which have come from the maternal and from the paternal side of the house.

Unfortunately for those who want a smooth and easy down-hill road to learning, but fortunately for evolutionary progress, the actual affairs of life are a little more complicated than we have made out in the above description. It will have occurred to the reader that if each chromosome is really a train freighted with character possibilities, and if each one of these trains is carried over bodily to a germ-cell, then the whole of the possibilities with which this train is loaded must come from either the father or the mother, as the case may be. But such an eventuality would not have suited Mother Nature, who wants great variability among her children in order to evolve better strains. For this reason, that is, to provide for maximum diversity, there is a point when the germ-cells are maturing when each pair of freight-trains may exchange cars. Train number one can exchange only with its homologue the second train number one from the other side of the house, and the exchange must take place in a definite manner; but experiment has determined that it does take place, and many of the laws of this exchange have been worked out.

If one now gets clearly in mind that the characters of an organism are fixed by numerous germ-cell determiners or genes except as their development may be promoted or retarded by environmental conditions, that each body-cell possesses a pair of each of the genes, one contributed by the father and one by the mother, that these genes are unchanged by their close association yet work together in developing the tissues and organs, that the two genes forming a pair of homologues may be unlike, and therefore may function differently, that there may be any combination of the choice of one out of each pair of genes in making up the genetic constitution of each germ-cell, and that fertilisation is a chance affair and does not occur more frequently because of a particular germ-cell constitution, he is then ac-

quainted with the operation of the more important machines in the heredity workshop, and is ready to take up the consideration of their output. Two simple cases of inheritance will show what happens.

The body-cells of man contain 48 chromosomes, thereby giving opportunity for a most extraordinary recombination of the characters by which the parents differ; but for our purposes here all but four can be disregarded if we remember that the other chromosomes may contain genes which to some extent modify the development of the characters controlled primarily by the four chromosomes used in the illustrations.

Suppose we consider first a *pure* brown-eyed person, let us say a native of the south of Italy. Where does he get his brown eyes? And why do we say he is a *pure* brown? Why are not his eyes blue? As a matter of fact his eyes *are* blue. Every one has blue eyes except albinos. We simply do not see the blue because it is covered up by the brown. He is a brown because in addition to the genes for blue eyes he has genes for brown. And he is pure for brown because each member of one of his pairs of chromosomes contains the gene for brown. Thus he can transmit only the brown condition to his children, for all his germ-cells possess this power. Similarly a blue-eyed person transmits only blue eyes because neither member of the pair of chromosomes controlling that type of eye colour possesses the gene for brownness.

What happens, now, if this pure brown-eyed son of Italy marries a blue-eyed daughter of the Northland? All their children will be brown-eyed, though not so deeply brown-eyed as their father. The brown color is the dominating color, and it is produced as usual even though the determiner for it came from only one side of the family.

This fact does not seem odd, but the next step in the series, the result when children from this cross marry children from a similar cross, is a little more astonishing. Gen-

erally speaking, that is to say if we have a large family with which to deal, three-fourths are brown-eyed and one-fourth blue-eyed. The blue-eye trait, recessive as it is called, has appeared again.

For explanation of this occurrence we must remember the behaviour of the freight-train gene-carriers. The hybrid children in each case are hybrid for browneye-blueeye because one chromosome gives a brown-eye and one a blue-eye inheritance. When their germ-cells are formed, one-half possesses genes for brown eyes and one-half genes for blue eyes. The problem of what occurs at the union of two such individuals, therefore, is simply the problem of the union of female germ-cells half of which we may regard as brown and half as blue with male germ-cells half of which are brown and half blue. And we may work out for ourselves the possibilities by a very simple experiment. Take a soft hat to represent the father and place in it 100 marbles, half of them brown and half of them blue. Then take one of those bedecked creations of the modern milliner and place in it yet another 100 marbles, half of them brown and half blue. This represents the mother. The next step is to draw one marble from each hat. This represents the first-born. Continue thus until you have a large family and you will find that about one-fourth of the time two brown balls have been drawn, about one-half of the time one brown and one blue ball have appeared, while the remainder of the drawings have given two blue balls. Three-fourths of our make-believe family are brown-eyed because that colour dominates, but genetically there are two types with different endowments to hand on.

Our second illustration will be of a very different character, but the results we will find to be similar. It has to do with defective mentality. Feeble-mindedness is a group term which includes various kinds of abnormality. For practical purposes, however, one may consider that there are only two types, one the result of disease or injury, the

other due to defective germ-cells. Probably 75 per cent of all cases of mental defect is hereditary due to abnormality in a definite gene. It has an effect recessive to normal. If two normal germ-cells unite to produce a child, one can rest assured that this child will never show defective mentality except as disease or injury may intervene; and in the latter case the defect will not be transmitted by the possessor. So also the little one whose heritage is from one defective and one normal germ-cell will be of normal mentality. Possibly he or she will not be as well provided with brains as a "pure" normal, but true feeble-mindedness will never be in evidence, since the defect is recessive to the normal. For these reasons also two such cross-bred persons, though apparently normal themselves, will produce feeble-minded children occasionally. Roughly, about 25 per cent will be thus characterised. Furthermore, two feeble-minded persons, since they possess no genes for normal mentality, will give rise only to feeble-minded offspring.

Suppose now we combine these two specimens of heredity. What happens if the cross is a blue-eyed normal person with a brown-eyed defective? As one might expect, there is nothing exceptional in the first generation. Each dominant character manifests itself in the manner already described. But let two such cross-breds mate and a new phenomenon presents itself. Recombination, the keystone of the whole genetic structure, occurs. Since each germ-cell must contain one of each pair of genes, normal or defective and brown or blue, and since there is equal opportunity for forming each combination, four germ-cell types will be produced in equal numbers; viz., brown-eyed normal, brown-eyed defective, blue-eyed normal, and blue-eyed defective.

The problem of what takes place in matings where such germ-cells have the opportunity of meeting at the mating of two similarly constituted hybrids of this kind can be solved by marking half of the brown and half of the blue marbles used in the first experiment with an "N" for Normal

and the other half with a "*D*" for Defective, and again drawing pairs from the two hats and recording the result. Experimentation of this kind is not silly and leads to an appreciation of the laws of probability hardly to be gained in any other way; but there is an easier method merely to work out an answer to the questions set. Since there is equal opportunity of each of the four types of germ-cells produced by the female in this make-believe mating to meet the four types produced by the male, just write down those combinations by ordinary multiplication. When they are totalled it will be found that there are nine brown-eyed normals, three brown-eyed defectives, three blue-eyed normals, and one blue-eyed defective. And an examination of the records with regard to whether the dominant characters come from only one side or from both sides of the house will show how these individuals will transmit their respective heritages.

Perhaps this brief introduction to the mechanics of heredity will seem to be a sandy foundation for a genetic philosophy, but it is not. It forms a solid basis for a new social outlook.

Just as, chemically, we are a collection of molecules, genetically we are a combination of more or less independently inherited characters whose germ-cell representatives are the genes. The genes are self-perpetuating bodies which grow and divide through long periods of racial history, retaining their individuality and showing practically no variation in the functions they perform. Yet in rare cases they may change. They may take on new constitutions. And when they do, a new variation, a new trait, appears. In fact, this is the only means by which something really different can appear, the only raw material for the hand of Evolution.

In spite of this queer arrangement for descent, however, we are not put together like a mosaic pavement. One gene usually affects many characters, and one character is pre-

sumably the effect of many genes. Such a provision was a particularly wise scheme on the part of Nature. It provides for variant combinations in a way which no other plan free from intricacy could possibly have done. It is the complementary device which allows the simple mechanical method of inheritance to provide unending variety. A change in a single one of our genes, for example, and defective mentality is produced when the changed genes are received from both sides of the family; but there are probably hundreds of genes which shift the grade of defectiveness higher or lower, just as there are hundreds of genes which make for various grades of normal mentality.

The genes, one may say, are the silver bromide and the rays of sunlight which, acting together, provide the opportunities for an endless series of pictures; environment is the developer which makes or mars the result. It is foolish, therefore, to discuss whether heredity or environment plays the greater rôle in life. One might as well ask whether food or water is more important to the individual. Both are indispensable, but their functions are different. Our heritage is Nature's gift, closing some channels, opening others; the conditions or influences which surround us, the education we are offered, is opportunity stationed ready to measure what we do with our endowments with yardsticks of relativity which vary with the case in hand.

CHAPTER IV

THE GRAMMAR OF HEREDITY

THE rediscovery and corroboration of Mendel's forgotten work and the publication of DeVries's experiments upon the methodology of evolution, which came just at the beginning of the twentieth century, inspired biologists with new zeal. Numerous investigators in all parts of the world began to cross and recross varieties, and to bring order out of the seeming chaos of the results which they obtained. It was fascinating work to follow the appearance of a given character or group of characters through a series of controlled matings and to find that they obeyed definite laws with mathematical precision. As one of those who succumbed to the infection, I can testify to the never-failing astonishment and delight as experiment succeeded experiment in which hybrids between two unimportant and innocuous-looking beans or two miserable harlequins of the mouse family were found to transmit their peculiarities with an exactness that could be recorded in the terms of an algebraic equation.

During the next decade or so these enthusiasts covered a great deal of ground, if such an indifferent phrase can be used to express the magnitude of their efforts. The botanical material, besides numerous flowering plants, included genera from the ferns, the mosses, the liverworts, the fungi, and the algæ; the zoölogical types, in addition to a long list of insects and of mammals, embraced birds, amphibians, reptiles, fishes, and mollusks. Human heredity was also studied in great detail, though here analysis was necessarily confined to genealogical records, which are always incomplete and often erroneous.

Attention is called to the great genetic activity and to

the variety of forms utilised, for a specific reason. Students of cell-mechanics had found that all of the species in this heterogeneous collection of animals and vegetables appeared to have essentially the same machinery for distributing hereditary characters. The cells of each species were found to contain a definite number of chromosomes; and these chromosomes, whether from morning-glories, silkworms, or monkeys, behaved similarly during the cell-divisions of egg and sperm maturation, during the process of fertilisation, and during the cell-divisions of ordinary development. In their turn, the experimentalists found that each one of this varied assortment of organisms exhibited the same type of distribution of hereditary characters; and this method of inheritance is that which is required mathematically by the observed distribution of the chromosomes. By all rules of logic, therefore, these facts alone prove that there is a single grand plan, varying only in detail, by which hereditary characters are passed from generation to generation throughout the whole of the animal and vegetable world.

We will see more clearly how this generalised heredity mechanism works if we examine the results of some of the hybridisers. Their records are in terms of characters instead of chromosomes, and are therefore more interesting; nevertheless, it must be remembered that characters are merely the end results of chromosome activities. A friendly environment is necessary to get the desired result, or to get any result at all, just as gasoline is necessary to run an automobile; but the differences between two organisms are not due primarily to environment any more than the differences between a Rolls and a Ford are due to the fuel used. The chromosomes are workshops, stocked carefully with the machinery and the material required for the particular end in view; the function of the environment is simply to provide working conditions. If the plans have been laid at fertilisation to manufacture large juicy red apples, conditions may be so bad that the factory cannot turn a wheel,

or they may be just good enough to produce little red apples, dry and flavourless; but no matter what occurs to promote factory efficiency, the product will not be tasty yellow pears.

Crossing experiments have furnished explanations of many enigmas, not the least engaging of which are some ancient and honourable puzzles arising from the experiences of horticulturists and breeders of fancy stocks.

There are a dozen or more species of garden flowers in which certain delightful colours will not breed true, but always throw undesirable shades. There is the commercial form of carnation, popular everywhere, half the seedlings of which are not like the mother plant but are a mixture of single flowers and of monstrous flowers known as "busters." There is the handsome *grey* strain of fowls known as Blue Andalusians,¹ which are no more true to their race than they are to their name. When blues are bred with blues, they produce blacks, blues, and whites splashed with blue.

Bateson, the eminent English zoölogist, discovered the reason for these phenomena, which are essentially alike. The quality which distinguishes Andalusians is what Mendel called a hybrid-character. They have received a character-determiner, or gene, for black plumage from one side of the house, and a gene for splashed white from the other side. It makes no difference which quality comes from the father and which from the mother, the result is the same; the interaction of these two unlike genes produces a "blue." The genes which thus work in copartnership during the growth of the fowl to maturity never lose their identity, however; and when the reproductive cells are formed, they separate and pass to different cells without the slightest indication in their future behaviour that they had been shipmates for a time. It is impossible for the Andalusians to breed true, therefore, since by chance fertilisation the result verges towards the ratio one black-black plus two

¹ For a more extended account of this phenomenon, see Bateson's work, *Mendel's Principles of Heredity*, Cambridge University Press, 1909.

black-white plus one white-white, using the colour terms to denote the genes. The way to obtain a hundred per cent of true Andalusians is not by mating blues but by the paradox of mating the despised blacks and whites together. Since the germ-cells of the white birds bear only genes for white and the germ-cells of the black birds bear only genes for black, the resulting genetic constitution is always black-white; and such birds are Andalusians.

This is a nice example of a case where the effect of neither gene dominates that of the other. They merely work together, and their co-operative effort is different from what either would accomplish alone. Dominance, in fact, is one of the most variable phenomena of inheritance. Occasionally it is perfect, as in many crosses where flower colours, fruit colours, or the colours of the coats of animals are under observation. For instance, there are several red varieties of the sweet pea which, when crossed with white varieties, give hybrids indistinguishable from the pure reds. And one may wager with perfect safety that no fancier can tell a pure strain of black rabbits from a litter produced by mating black with white. Genetically this means that the heritage of black from both sides of the house BB is worth no more for developing coat colour than the heritage of a single gene Bb , using small b to denote absence of power to develop black. Ordinarily, however, the heterozygote, as the hybrid-character individual is called, is fairly easily marked off from the homozygote or pure type. The XX guinea-pig or rat or man is somewhat different from the Xx . In the latter case the heterozygotes when interbred give three visibly different classes approaching the ratio of 1:2:1 as follows:

X eggs + X sperms give pure type XX .

$\left\{ \begin{array}{l} X \text{ eggs} + x \text{ sperms give hybrid type } Xx. \\ x \text{ eggs} + X \text{ sperms give hybrid type } Xx. \end{array} \right\}$

x eggs + x sperms give pure type xx .

In the former case there are only two visibly different classes, because the first three groups in the above scheme all appear to be alike, and can be separated only by recording the way they breed.

As these examples show, dominance goes by no rule. If one wishes to know how two varietal characters react in crosses, he must study an actual mating. Ordinarily when this is done, the matter is settled. The dominance and recessiveness of a pair of characters once recorded, the information can be used for purposes of prediction in future crosses. In fact, if successive experiments of this type are really identical, the results will always be the same, since it is a cardinal principle of science that like causes produce like effects.

Unfortunately, there are several ways of being deceived in this regard. Sometimes the workers are in the position of the spectators at a sleight-of-hand performance. Their eyes betray them. Among fowls there are races with white and races with coloured plumage. Among the various cultivated flowers, white and coloured varieties within the same species are the general rule. These whites appear to be exactly alike, but genetically they are often different. The White Leghorn fowl when crossed with coloured breeds is dominant; certain White Bantams and White Silky fowls in the same combinations are recessive to colour. Thus there appears to be a reversal of dominance without visible cause. In reality there is no mystery. The whites give different results only when they have different genetic constitutions. The white of the Leghorn actually prevents the development of black colour when in such a cross, the White Bantam merely has its effect concealed by the colour production engineered by the black gene. This explanation can be proved, moreover, by the proper matings. The black recessives extracted from a cross with dominant whites always breed true; the blacks from the first generation of the other cross produce whites in the second hybrid generation.

And the recessive whites thus obtained are recessive in all crosses with coloured strains. No other evidence is really needed to demonstrate the point, but, just to clinch matters, the poultry-breeders have produced synthetic white races having genes both for the colour inhibitor *II* and for the recessive white *cc* (absence of colour). Such birds give the results expected by the theory when crossed with coloured breeds, and these results are not those obtained when either of the first two whites are used. The birds of the first hybrid generation are all white; but, unlike the other instances, there is a ratio of 13 whites to 3 coloured in the second hybrid generation, and only 1 out of 3 of the coloured birds breeds true to type.

In addition to being tricked by our eyes into misclassifying individuals, there is also the difficulty of controlling environmental conditions during an experiment. Only rarely does an ordinary variation in the factors of environment bring about sufficient deviation in the development of a character to cause difficulty in interpreting breeding results, but occasionally this happens, and the matter is of some importance as showing the true distinction between the rôles played by environment and by heredity.

Morgan,¹ while studying inheritance in the fruit-fly, discovered a strain which often had 12 legs instead of 6, but he was never able to get the race to breed true until he found out by accident that an ice-box was the home atmosphere it required. Similarly Baur isolated some primroses which developed the red colour with which they were endowed by inheritance only at a greenhouse temperature of 68 degrees; when the plants were kept at 86 degrees, they produced white flowers. And I have found corn plants which in the shade of their own husk produced white ears, but in direct sunlight developed red ears.

These examples show plainly that without the proper

¹ See T. H. Morgan. *The Physical Basis of Heredity*. Philadelphia, Lippincott, 1919. Also, for more technical accounts of genetic work on *Drosophila melanogaster*, see T. H. Morgan, C. B. Bridges, and A. H. Sturtevant, *The Genetics of Drosophila*. 's-Gravenhage, Nijhoff, 1925.

genes, without the necessary heritage, in other words, environment can do nothing. Given the right hereditary endowment, development is promoted or retarded by the circumstances encountered during the process. Would we might take this fact to heart and make it a part of our social doctrine. We can lead a boy to the schoolhouse but we can't give him brains.

Another queer story is *The Case of the Yellow Mice*, which, though not a title from the *Arabian Nights*, is not far from resembling one of those classical tales in that it is passing strange.

Yellow mice when crossed with black races show dominance of the yellow condition, which is just the opposite of what occurs in rabbits. A difference between two species in the dominance and recessiveness of a pair of characters apparently alike need not surprise one, however, since external resemblances are often superficial. The chief point of interest is that while pure races of yellow rabbits are common enough—or would be if they were not so homely—mice which breed true for yellow are never obtained. Yellows from a yellow-black cross when interbred always throw both yellows and blacks; yet this is not a situation analogous to that of the Andalusian fowls, because only one class breeds true, the blacks.

Cuénot,¹ the French geneticist, who first reported this case, thought there might be some incompatibility which prevented two yellow-bearing germ-cells from uniting in fertilisation, but this interpretation did not prove to be correct. By studying large numbers, Little² found that yellows interbred threw just about two yellows to one black, and produced small litters. This fact gave him the clew to the affair. Pure yellows were formed in normal numbers, but did not develop beyond a very early stage. And by embryological examinations he proved his point.

¹ L. Cuénot. "Un paradoxe héréditaire chez les souris." *Bull. Mens. de la Réunion Biol. de Nancy*, 1904.

² C. C. Little. "Experimental Studies of the Inheritance of Colour in Mice." *Carnegie Inst., Wash., Pub.* 179, 1913.

To-day hundreds of such genes are known in various animals and plants. Lethal genes they have been termed. An organism may get along perfectly well with one of these genes. The effect of the normal gene paired with the lethal allows the possessor to go through life peacefully unconscious that, genetically, it is half dead. But let there be a double dose of these lethal genes, one from each parent, and the effect is no more doubtful than that of a double dose of arsenic.

Were heredity always such an open matter as in the cases we have described, the geneticist would have been forced to seek another occupation long ago. Happily he can work contentedly with his guinea-pigs and his rabbits and his genealogical tables for some time to come, because life is complex. Even when two character pairs are studied instead of one, the new possibilities for odd and interesting aspects of the subject become simply enormous. We shall describe two or three such cases, but in order to make the matter clear, a word must be said about genetic arithmetic.

Since the physical basis of heredity is the chromosomes, and the chief mechanism for the distribution of hereditary characters is the separation of the homologous chromosome pairs of the body-cells to form the single series characteristic of each egg or sperm, there is a simple method of calculating the germ-cell formula for any number of pairs of genes. A pair of genes Aa will separate into equal numbers of A and a at germ-cell maturation. Similarly a pair of genes Bb will separate into equal numbers of B and b . But, since each germ-cell must have one member of both pairs, one can be certain of getting all combination thus:

$$A \begin{cases} B = AB \\ b = Ab \end{cases}$$

$$a \begin{cases} B = aB \\ b = ab \end{cases}$$

And this scheme can be extended indefinitely, the addition

of a third pair of genes Cc giving $A \begin{cases} B \\ b \end{cases} \begin{cases} C \\ c \end{cases}$ and so on.

The types of progeny obtained when these germ-cells meet at fertilisation, since there are equal numbers of all types, are found by multiplying $AB + Ab + aB + ab$, representing the eggs, by the same formula representing the sperms.

There is certainly nothing complex in this way of working out the progeny ratios expected from a hybrid, but those who have become addicted to the cross-word puzzle habit may be able to visualise matters a little better by using the checker-board method invented by Punnett. Let us take as an example a pea cross made by Mendel where the contrasting pairs of characters are green pod (A) dominant to yellow pod (a) and reddish flowers (B) dominant to white flowers (b). The female germ-cell formulæ are written vertically and the male germ-cell formulæ horizontally, the compartments where they meet giving the genetic constitution of the individuals formed by the respective fertilisations.

		Germ-cells of male			
		AB	Ab	aB	ab
Germ-cells of Female	AB	$AABB$	$AABb$	$AaBB$	$AaBb$
	Ab	$AABb$	$AAbb$	$AaBb$	$Aabb$
	aB	$AaBB$	$AaBb$	$aaBB$	$aaBb$
	ab	$AaBb$	$Aabb$	$aaBb$	$aabb$

If one collects the above terms keeping in mind that there is dominance in each of the character pairs, and that for this reason individuals of the Aa type are like those of the AA type externally, he finds that there are 9 green pod, red flowers: 3 green pod, white flowers: 3 yellow pod, red flowers:

1 yellow pod, white flower. In addition, one can see how each of the individuals of these classes will breed by noting whether they are homozygous (AA) or heterozygous (Aa).

Tedious though this little excursion into arithmetic may have been, it was necessary. It is impossible to understand genetic discoveries if one does not learn the alphabet with which the results must be described.

The progeny ratio of two-character hybrids, which consists of 9 individuals having the two dominant characters, 3 having the first dominant combined with the second recessive, 3 having the second dominant combined with the first recessive, and 1 having both recessive characters, is a sort of a standard affair from which many modifications emerge. One of the interesting examples of this sort of thing, which will serve to show more clearly than would any amount of abstract discussion how the genes of the germ-cells function in real life, is Bateson's work on the combs of fowls. It is an illustration of the way in which genes belonging to distinct chromosome pairs, and inherited independently of each other, may work together to produce compound characters.

There are various forms of comb in the different breeds of the domestic fowl. The stately serrated type known as Single which is carried by the Leghorns is perhaps the most familiar, although the Pea-comb characteristics of Indian Games and the Rose comb possessed by Hamburgs and Wyandottes are not uncommon.

Bateson found that both the Pea comb and the Rose comb were dominant in crosses with the Single comb, and behaved in the manner regularly expected when a single gene pair is concerned. Such a result was somewhat confusing. Here were Rose comb crossed with Single comb, and Pea comb crossed with Single comb, each acting as if they were induced by paired genes. If this were true all three types would be due to variations in the same gene, and hybrids between any two types should throw progeny

of those two types only, because there is no other possibility with a single pair of genes controlling the matter. But this was not the result obtained. When Rose combs were crossed with Pea combs the hybrids had the curiously corrugated comb characteristic of Malay fowls which is known to fanciers as Walnut; and their progeny consisted of Walnut, Rose, Pea, and Single in the ratio of 9, 3, 3, and 1. Single comb had appeared, though it had not been put into the cross knowingly.

Bateson's analysis of these breeding records made quite a change in genetic conceptions. The Walnut type was evidently a compound character produced by the mutual interaction of the genes which induced the Rose and the Pea combs respectively when acting alone. Single was produced by a distinct gene which was a sort of a fundamental requirement for comb growth, yet of such a nature that it was either hidden or modified by the presence of the genes for either Pea or Rose. It is necessary therefore to think of a dominant gene, "*A*," as the *presence* of something which induces a particular result, and its recessive mate, "*a*," not as emptiness or nothingness, but as the absence of the ability to do the job of the dominant. Thus the genetic constitutions of the fowls under consideration may be expressed as:

Walnut.....	<i>PPRRSS</i>
Pea.....	<i>PPrrSS</i>
Rose.....	<i>ppRRSS</i>
Single.....	<i>pprrSS</i>

That this interpretation is the proper one was proved by crossing each of the three complex comb types with the Breda fowl which has no comb whatever, and, therefore, may be described with the formula *pprrss*. In every case Singles were obtained in the second hybrid generation as called for by the theory.

Many hoary old heredity puzzles have yielded to similar explanations. The character causing the trouble was a

compound character, and needed two pairs of genes to come into visible expression. What is known as Atavism or Reversion after Crossing, a classic since Darwin's time, belongs to this category.

When certain white sweet peas are crossed a purple results, and the purples when self-fertilised yield purples and whites in the ratio of 9 : 7. Our old friend the 9 : 3 : 3 : 1 ratio here appears in disguise because the individuals belonging to the last three terms are indistinguishable. They can be separated only by breeding tests. What happens may be described by saying that the white variety *ppCC* was crossed with the white variety *PPcc*, and that *C* and *P* having been brought together, colour developed.

A similar explanation holds for various crosses among mammals and birds where the mating of two domestic breeds produces a reversion to the characters of the wild type from which they sprang. For example, a black rabbit and a white rabbit mated may produce nothing but grey offspring, and these hybrids when interbred produce greys, blacks, and whites in the ratio of 9 : 3 : 4. Again we have the standard ratio for two pairs of genes, this time with two classes indistinguishable. The black rabbits owe their colour to the interaction of two sets of genes, *BB* and *CC*, but lack the greying gene *GG*. The white rabbits possess the greying gene *GG* and the black gene *BB*, but are white because they lack the basic colour gene *CC*. The result of the cross is a grey heterozygote *GgBBCc*, and these greys when interbred produce greys, blacks, and whites by recombination of the two heterozygous determiners.

Simple heredity phenomena yield readily to this type of interpretation, though one may obtain progeny ratios varying markedly from those cited because of the small numbers involved, because a single chromosome directs the action of several character-determiners, because the activity of more than one determiner is needed to produce a visible result, or for any one of a dozen other reasons. Nevertheless,

the laws of gene segregation and of independent recombination of genes, which are the principles now under consideration, are by no means the complete story upon which the modern genetic philosophy is built.

The genes retain their individuality under all circumstances. They do not blend or amalgamate. The law of segregation, therefore, is universally valid. If the chromosomes are freight-train carriers loaded with genes, however, it is obvious that *independent* segregation occurs only when the genes under consideration are located in separate chromosomes. The freight contained in each chromosome, or let us say in each train, and thus the characters which develop from the activities of its baggage, must show some sort of association in inheritance. There can be only as many *independent* recombinations of characters as there are pairs of chromosomes in the species.

This statement of the case is accepted as valid, though it has been proven only in one organism, the common fruit-fly (*Drosophila melanogaster*). The fruit-fly, which is the tiny pest found so commonly feeding on decaying bananas, has been a Rosetta stone to genetics. It has only four pairs of chromosomes and a very large number of varieties with distinctive characters. The inheritance of over 400 of these traits has been worked out and from these studies a remarkably clear idea of the architecture of its germ-plasm has been obtained. This is not the place to undertake a technical description of the experiments which have yielded up so many secrets. For such discussions several books by T. H. Morgan,¹ who has directed the work, are available. Briefly, in these experiments, conducted with marvellous ingenuity, extending over 18 years, involving the examination of hundreds of thousands of individuals from controlled matings, Professor Morgan has shown that there are only four groups of characters—we are really speaking of

¹ Besides the volumes by T. H. Morgan already cited, see *The Theory of the Gene*, Yale University Press, 1926.

genes of course—corresponding to the number of chromosome pairs, which are absolutely independent of each other in inheritance. Within each group the traits tend to be associated with each other when they are transmitted from generation to generation. Furthermore, they behave as if they were located in definite positions within each chromosome, in a linear series, like beads on a string. Portions of each string may be exchanged in the formation of the germ-cells, but in these portions the genes retain their fixed relations with each other. It is somewhat as if the words which make up two sentences could be exchanged with each other, it being against the rule to transpose the letters.

In no other organism has it been shown that the number of groups of characters associated with each other in inheritance—linkage groups they are called—is identical with the number of chromosome pairs; but this is because no other organism providing satisfactory material for genetic studies has a small enough number of chromosomes to make the determination easy. Yet there is a great deal of valid evidence that this is a general law. In Indian corn there are ten pairs of chromosomes, and eight linkage groups are known. The garden pea has seven pairs of chromosomes, and five linkage groups have been found. In fact, from two to five linkage groups are known in numerous species of both animals and plants.

The existence of linkage introduces some complications into the results actually obtained from crosses, yet the analysis of this elaborate provision for the transmission of characters was a great advance for genetics. It completed the proof that the chromosomes are the effective agents in heredity. And the theoretical interpretation of linked inheritance is quite simple.

If every gene contained in a given chromosome were always transmitted together we could learn nothing of the way the germ-plasm is put together. In the second chromosome of the male fruit-fly nearly 100 genes have been

located and their positions mapped in relation to one another; yet if the only available breeding data were like those from the male fly, one could not be certain that more than a single gene is involved, for the individuals of the harsher sex invariably transmit these numerous peculiarities together. How, then, was the truth discovered? By the behaviour of the females. Like the females of some other species, they are more variable and inconstant than the males. An illustration or two should make this matter clear.

Normally the legs of the fruit-fly are fairly long, and their wings are those ordinarily to be expected in the species; but families exist with short legs and with rudimentary wings to which the respective names Dachs and Vestigial have been given. For convenience the breed with the wild-type legs will be designated "*Da*," and that with the ordinary wings "*V*"; while the abnormal types will be denoted by the terms "*da*" and "*v*." The genes responsible for these differences lie in the second chromosome, and requisite matings have shown that they always stay together in the male. They are completely linked. But voluminous evidence shows that they sometimes break apart when the germ-cells of the female are formed. Linkage there is incomplete.

Let us assume that a female has been obtained from a mating between a long-legged, normal-winged (*Da-V*) male and a dachs vestigial (*da-v*) female. Her body-cells, as well as those of a male of similar derivation, will have the genetic composition *Da-V:da-v* with respect to these characters. A male of this constitution will produce germ-cells only of types *Da-V* and *da-v*, since the genes entering the cross together stay together. But in the female the thing works out differently. She produces germ-cells of four kinds: a larger number of *Da-V* and *da-v* cells, in equal quantities; and a smaller number of *Da-v* and *da-V* cells, still in equal quantities. And when large numbers are counted and adjusted to a uniform standard, it is found that 64 per cent of

the germ-cells are of the linked types, *Da-V* and *da-v*; while 36 per cent are of the broken-linkage or crossover types, *Da-v* and *da-V*.

The same machinery operates if the hybrid female is produced by parents in which the genes are linked in the opposite way. Assume her father to have been long-legged and vestigial-winged (*Da-v*) instead of long-legged and normal-winged (*Da-V*), and her mother to have been dachs-legged and normal-winged (*da-V*) instead of dachs-legged and vestigial-winged (*da-v*). *In this case the genes would also tend to stay linked in the way they entered the cross, and the strength of the linkage would be as before.* Sixty-four per cent of the germ-cells would be *Da-v* and *da-V*, while 36 per cent would be *Da-V* and *da-v*. Thus linkage is ruled by law, and breaks in linkage relations obey the rules.

It is through studying the frequency of linkage breaks, or crossovers, that much of the knowledge regarding the location of the genes within the chromosome has been obtained. Maps of the genes of various chromosomes have been constructed, on the basis of crossover percentages. In this way it has been determined that the genes lie one after another—like beads on a string, as I said once before—and that they cross over in blocks, the while *retaining their respective positions.*

Thus a mating can be made in which genes *ABCDEFGHI* can be followed by opposing the homologous genes *abcdefghi*. When this is done, genes can be traced where the exchange results in germ-cells *ABCdefghi* and *abcDEFGHI*, or in germ-cells *ABCDEFghi* and *abcdefGHI*, and so on. In every case exchange is according to rule, and the rule is that the blocks of genes exchanged retain their respective positions in relation to each other.

But I shall have to haul up. I undertook not to go into the technicalities of genetics. What I really wish to bring out in connection with the subject of linkage is how the ratios of progeny produced by hybrids are affected. Recall

that the normal ratio obtained in the second hybrid generation when two independently recombining factors are followed is $9 AB:3 Ab:3 aB:1 ab$. In general, only one individual containing both recessive characters is found for every 16 in the family. And this is due to the fact that the four kinds of genes are formed in equal numbers: viz., AB , Ab , aB , and ab . If one-fourth of the egg-cells are ab and one-fourth of the sperm-cells are ab , then they must meet and form organisms $aabb$ in that fraction of the total unions given by $\frac{1}{4} \times \frac{1}{4}$, or $\frac{1}{16}$. And the same results are obtained whether A and B enter the cross together or separately. Where there is linkage, on the other hand, the progeny ratios are quite unlike the $9:3:3:1$ ratio given above, and they differ markedly from each other, depending upon whether A and B enter the fertilised egg together or separately. Moreover, the ratios change according to the strength of linkage. Suppose A and B are linked so strongly that the linked germ-cells are formed nine times as often as the crossover germ-cells. If the cross is $AB \times ab$, then the germ-cells formed in the hybrids are $9 AB:1 Ab:1 aB:9 ab$ when there is crossing-over in both sexes, and the progeny of the hybrids tend to approach the ratio $70 AB:4.8 Ab:4.8 aB:20 ab$. Thus the middle terms are smaller and the end terms are larger than with free recombination. If, on the other hand, the cross is $Ab \times aB$, then the germ-cells formed in the hybrids are $1 AB:9 Ab:9 aB:1 ab$, and the progeny of the hybrid tend to approach the ratio $502 AB:248 Ab:248 aB:2 ab$. The double recessive ab tends to disappear.

So many seemingly exceptional examples of inheritance are known to each one of us, that our emphatic statements as to the inclusiveness of the laws outlined in the preceding pages may seem to be the exaggerations of an enthusiast. But the difficulties lie with our facts, or our lack of facts, not with the laws. When there is sufficient evidence the difficulties fade away. Ordinary alternative inheritance, as it may be called, holds for all characters of animals and

plants which produce their germ-cells by normal methods of chromosome reduction. A few examples of exceptional chromosome behaviour are known in certain of the lower organisms; but these cases can hardly be called exceptions, since the genes still remain attributes of the chromosomes, and only their distribution is anomalous.

Even characters which apparently blend in the hybrids, such as the skin colour of the mulatto, or the size of organs or of organisms, obey the laws of alternative inheritance. The reason blends occur is because there is very little dominance manifested in the effects of the genes concerned, and the reason the progeny of these blends seldom show a complete return to the qualities of the grandparents is because the grandparental differences are due to the effects of so many genes that a very large progeny is needed to have reasonable assurance of observing such a result. As a matter of fact, out of every hundred or so children produced by mulatto unions, one is Caucasian as far as skin colour goes; and this is a matter of some moment now the negroes are becoming more widely distributed in America, for a white skin does not necessarily imply a lack of other negro characteristics either physical or mental.

In the older books on heredity, blending inheritance was described as a distinct type. Quantitative characters, that is, characters in which individuals differed in degree only, were said to blend. Analysis of this mode of inheritance and proof that it was alternative was an important genetic step, therefore, since by far the greater number of differences between individuals belong to this category.

The possibility of harmonising these supposedly different types of inheritance was seen when it was discovered that certain species have genes located in different chromosomes which can perform practically the same function. For example, some wheats have red seed-coats, others white seed-coats. Usually this difference is due to the action of a single

pair of genes, which may be denoted by R and r . Red being always dominant, the second hybrid generation consists of three reds to one white. But one extraordinary case was found where a red wheat crossed with a white produced 15 reds to 1 white in the second hybrid generation. Clearly this result was due to the action of two gene pairs having apparently identical functions, which may be designated R_1 and R_2 , and r_1 and r_2 . The hybrid has the composition $R_1r_1R_2r_2$; and since the two pairs of genes recombine independently, the double recessives $r_1r_1r_2r_2$ are the only white segregates. These appear only once in every 16 of the progeny. Since wheats with either the genetic composition $R_1R_1r_2r_2$ or $r_1r_1R_2R_2$ are red and similar yet not so dark a red as plants with the constitution $R_1R_1R_2R_2$, it is clear that there is here the basis for inheritance of quantitative characters by the ordinary alternate heredity scheme. In addition there is a simple explanation for the appearance of anomalous individuals whose characters cannot be traced in the immediate ancestry. Wheat $R_1R_1r_2r_2$ is a red similar to the red of wheat $r_1r_1R_2R_2$; yet when the two are crossed white individuals $r_1r_1r_2r_2$ appear in the progeny of the hybrid owing to the usual recombination of genes.

The easiest way to get an idea of how the mechanism works in the case of quantitative characters¹ is to take a hypothetical case where there is an 8-inch difference between two plants, which is assumed to be due to two similar pairs of independently inherited genes. The smaller plant ($aabb$) is 12 inches high, let us say; the taller plant ($AABB$) is 20 inches high; the difference is due entirely to the action of the genes specified. The first generation hybrids are all of the constitution $AaBb$, and are 16 inches high, since the presence of every gene represented by a capital letter is as-

¹A good account of the inheritance of quantitative characters is given by E. W. Sinnott and L. C. Dunn, *Principles of Genetics*. New York, McGraw-Hill, 1925.

sumed to add 2 inches to the height. In the second hybrid generation the progeny are of the following constitutions and heights:

1 plant	12 inches	—	1 <i>aabb</i>
4 plants	14 inches		{ 2 <i>Aabb</i> 2 <i>aaBb</i>
6 plants	16 inches		{ 4 <i>AaBb</i> 1 <i>AAbb</i> 1 <i>aaBB</i>
4 plants	18 inches		{ 2 <i>AaBB</i> 2 <i>AABb</i>
1 plant	20 inches	—	1 <i>AABB</i>

Naturally, in real life the results are more complex than in this example. Numerous genes function in the production of most size differences, and when more than ten are involved, it takes an inconceivably large number of progeny to insure a combination that is identical with one of the grandparents. Their effects are also different. Rarely do two genes react in the same way. The handiwork of certain determiners may be out of all proportion to that of others. Environmental effects are also considerable. Nevertheless, mathematical analyses of the results of numerous crosses have shown that size and other quantitative differences do in fact follow essentially this scheme in their inheritance. They mendelise.

Without some idea of the way quantitative characters are inherited, genetic generalisation was impossible; they are too numerous. When they were brought into line, the grammar of genetics was complete. One had then an effective philosophy of heredity, valid alike for plants, for the lower animals, and for man.

The reaction of the majority of people after introduction to the principles of genetics is to become enthusiastic over their usefulness in agriculture and husbandry. This is unobjectionable. These principles do have a value to the farmer, and therefore to all the rest of us, not to be de-

spised. A smaller proportion see in them a second specific type of usefulness, the direct improvement of the human race. Here is knowledge, they reflect, by which man can direct his own evolution. By studying family trees, the outcome of various unions should be predictable. Whether the progeny from a given marriage will be brown-eyed or blue-eyed, dark-haired or light-haired, whether they will be susceptible or resistant to tuberculosis, asthma, and cancer, whether their natural heritage of life will be long or short, ought to be a matter of precise calculation. This again is good. Something can be done along these lines, although the prospects are by no means so rosy as some imaginative souls would have us believe. But to my mind the chief value of genetic knowledge lies in clarifying our general conceptions of social problems rather than in solving the knotty points of individual cases.

Man is a variable animal. We have only to look around us to see that this is true. The physical differences *between* races are extraordinary; the physical differences *within* a race are enormous. Naturally, the mental differences are just as great. We cannot suppose that Nature has produced the red man, the brown man, the white man, the black man, the pigmy and the giant, Ariel and Caliban, and has stopped there. No matter what value one may assign to precept and example in moulding the mind of man, his mentality is due fundamentally to his hereditary endowment, to his inborn traits. The difference between Isaac Newton and the sons of other gentlemen farmers was not due in any great measure to the political policies or the economic situation of seventeenth-century England, or to the educational advantages of Isaac, they were due to the germ-cells of Isaac Newton of Woolsthorpe and Hannah Ayscough.

Yes, mankind is an assemblage of the most diverse creatures. Men are cut from different patterns because they are mosaics, duplex mosaics, of innumerable genes. Their whole equipment, physical and intellectual, is due to an

assortment of building-stones received in part from their mothers and in part from their fathers, who in their turn received them from their mothers and fathers, and so on and on as far back as imagination leads. And because they are duplex mosaics, made up of pairs of genes which are not always identical, because they are hybrid for so many traits, their sons and daughters are different from themselves. What trains of thought these two facts kindle!

We can see clearly that marriage between near kin may strengthen a good house by concentrating desirable traits from both sides of the family. We can see no less clearly that inbreeding may weaken a house by uncovering a whole closet full of family skeletons—recessive abnormalities. The advantage of a reasonable amount of outbreeding is obvious. It increases variability. The disadvantage of unions between certain individuals of the primary races is understandable. It breaks up the smooth-running harmony of each, and increases variability to a point where selection of a better whole is almost impossible. The reasons for the weak, the strong, the obstinate, the yielding, the genius, the mediocrity, are displayed without a veil.

The geneticist yields to no one in his regard for good breeding. Contemplation of the records of fine old family lines brings joy to his heart. He likes to trace the influence of heredity in chronicles of achievement, to note how innate capacity has passed from knot to knot in the network of descent, and how the endowments of different individuals have manifested themselves variously, leaving their imprints now in the realm of business, now in that of science, and again in that of art. But no one knows better than he the fallacies of ancestor-worship. One outcross can spoil a lengthy line of irreproachable ancestors; one proper mating is all that is necessary to produce the real aristocrat. Unquestionably, it is better to be good ancestors than it is to have good ancestors.

The old conceit was an arrogant pride in blood, gentle

blood which at the worst risked only a slight dilution of its glorious powers by an ignoble union. To-day we put our faith in genes. It is rather difficult to become vainglorious and haughty over genes, but if we wish to assume such attitudes over our hereditary blessings, there is no other source from which to draw. And dilution, whether of power or of quality, is no attribute of a gene. The genetic constitution of a distinguished family is likely to be compounded largely of good qualities, hence the high probability of worth among its members; but the degenerate product of a bad genetic combination is not saved by the personal record of his ancestors. Nor, by the same token, is the genetically great damned because his endowments are the choicest gifts from a scanty store.

The clairvoyant mind of Lafcadio Hearn, philosopher as well as poet, saw many of these things. In *Gleamings from Buddha Fields* he gives us this thought, as accurate as it is beautiful:

I an individual—an individual soul! Nay, I am a population—a population unthinkable for multitude, even by groups of a thousand millions! Generations of generations I am, æons of æons! Countless times the concourse now making me has been scattered, and mixed with other scatterings. Of what concern, then, the next disintegration? Perhaps, after trillions of ages of burnings in different dynasties of suns, the very best of me may come together again.

CHAPTER V

HEREDITY AND SEX

AFRICAN travellers agree that no ostrich ever tried to out-manceuvre a danger by sticking his head in the desert sand. This recipe for solving problems was invented by man in order to deal with matters connected with sex. In a world peopled by men and women, the subject naturally holds an important position. Every social question arises from, or is linked with, the differences between the sexes; yet since the domination of St. Paul's theology civilised nations have tried to manage their affairs, posing the while as if the sexual factor were non-existent.

This pretense is passing, and we are well rid of it. We have begun to realise that the subjective dominance of the sex appeal, which shows so clearly in the love interests pervading our literature, drama, and art, is the emotion to be expected of normal people. The mask of apathy is the abnormal, and psychologists have shown that it often cloaks something more inglorious than mere sham.

Sex *is* an interesting subject. One may say this to-day without forfeiting his claim to respectability. It is interesting because apart from its other bearings it holds a prominent place among the objective studies of the biologist. And properly so. Sexual reproduction is the keystone of the whole evolutionary structure. This world would have had a monotonous history without it, not because it leads man to become a "chaos of thought and passion all confused," but because there would have been no such noble animal to disturb the music of the spheres. Our humble planet would have rolled on to its final doom of cold and death with the inglorious record of having produced nothing even as momentous and exciting as a jelly-fish or a grass-

hopper. Variety was the price of life for man, and no one of Nature's numerous experiments in propagation permitted the production of such varied forms as did the creation of a new individual by the union of two cells.

The reasons why such conclusions have been generally accepted are numerous. Perhaps the simplest argument is the following. We know that asexual methods of reproduction were not abandoned because they were too slow. In one week a vigorous fungus like the corn-smut can produce a number of potential new plants in the form of spores, greater than the total human population during the Christian era. The fusion of two cells is a distinct loss of time. We know too that spores, buds, bulbs, offshoots, and other similar methods of multiplication are very good means of keeping species flourishing, for numerous sorts which reproduce in this manner are with us to-day. But species which did not adopt sexual reproduction remained lowly and unspecialised, and species which abandoned it abandoned the road of progress at the same time. Why? Simply because evolution moves by steps, by mutations, and these changes are inherited independently of one another. When half-a-dozen mutations occur in a given stock of the asexual type, therefore, that stock has only six chances to escape annihilation at the ruthless hand of Natural Selection. There are six opportunities of fitting into the general scheme of things with the alternative of being removed from the scheme entirely. On the other hand, six variations in a sexually reproducing organism where there is an opportunity for crossing gives two to the sixth power possibilities for survival, or 64 all told, through hereditary recombination. It makes a great difference.

Formerly it was thought that species propagating only by asexual methods gradually died out through loss of some mysterious sort of vital energy. Why people drew such conclusions in face of the fact that some of the most ancient types show no traces of sex is an enigma which must be left

to the psychologist, but they did. They believed that sexual reproduction meant rejuvenation, a kind of fountain of youth. The idea appears to have arisen because *Paramecium*, a one-celled organism which is shaped like a bedroom-slipper, dies under ordinary laboratory conditions after a hundred or so generations of reproduction by division. Given the opportunity, however, these tiny slipper-animals fuse together. The twain become one flesh in physical reality, and afterwards return to asexual multiplication with great activity and vigour. Woodruff,¹ of Yale, and Jennings,² of Johns Hopkins, have given us the true explanation of this strange behaviour. These animalculæ are poisoned by the by-products of their own life processes. If waste products are removed and new food given periodically, *Paramecium* cultures can be kept in a perfect state of health for thousands of generations without conjugation, but conjugation serves as a kind of antidote to bad living conditions. By studying the behaviour of the descendants after conjugation, moreover, Jennings found that only certain ones show renewed vigour. It is believed, therefore, that conjugation is not of itself a rejuvenator, but that only those individuals having desirable combinations of hereditary characters profit by the transaction.

Essentially, sexual reproduction is a method of propagation dependent on the behaviour of the chromosomes. Again we must focus attention on those protoplasmic freight-trains within each living cell which link generation to generation, and whose operations with the materials they contain build up the body characters of every organism. When a type is sufficiently simple and unspecialised to go on its way living and reproducing its image by mere chromosome divisions, we say that its propagation is asexual; when a type propagates by a fusion of chromosome sets from two cells, we be-

¹ L. L. Woodruff. "The Life Cycle of *Paramecium* when Subjected to a Varied Environment." *Amer. Nat.*, 42, 1908.

² H. S. Jennings. *Behavior of the Lower Organisms*. New York, Macmillan, 1906.

lieve that it has taken on the significant features of sexual reproduction.

Nature is not niggardly in her experiments. She will try almost anything, not only once but many times. She believes in giving new ideas a chance. By all the evidence sex has arisen again and again in both the animal and vegetable kingdoms, and the various guises under which the scheme is carried on are almost innumerable. These various expedients, however, are but cloaks for one process, a shifting of chromosome materials in the preparation of the germ-cells and their further recombination at fertilisation.

What appears to be an origin of sex occurs to-day in the tiny green alga (*Ulothrix*) one finds as a scum in stagnant water. In this species large fat spores are formed when times are prosperous which need only proper housing conditions to germinate and produce their kind. Under the pressure of adversity, on the other hand, it produces starved-looking, lonely little spores which must cast their lot together so intimately as to become one body before they can start life anew. And among primitive animals a very similar round of affairs takes place.

After the origin of sex the evolutionary trend in both kingdoms was in astonishing agreement. First the germ-cells were like ordinary cells, showing their difference only in the attraction they had for one another; yet even so, there is no harm in calling one the male and the other the female. Afterwards, germ-cells distinct in form appeared. Still later, types arose in which specialised organs produced the germ-cells. The final step in each kingdom, the mammals and the seed plants, was the protection of the young.

Let us now forget the sex problems of the plants and turn our attention to the higher animals. We may excuse this partiality by two reasons. In the first place, the sex problems of the vegetable world are superficially even more complicated than those of the animal world. In the second place, we are not interested so much in plant biology as in

animal biology. Man recognises his mammalian relationships even when he will not admit it openly, and he likes to write and talk and speculate about matters that are at least related to his own private affairs.

In most of the higher animals there are males and females. There are hermaphroditic organisms, it is true, where the two kinds of germ-cells are borne in the same individual. There are even animals which are first females, because they bear eggs, and afterwards males, because they bear sperms. But this unusual type of sexuality is nearly always confined to forms that are parasitic or otherwise degenerate. The tapeworm is a good example. The old Hebrew observation, "male and female created he them," still holds as a fair approximation of the facts; and this brings up the question of what determines the proceeding. We know *why* there are males and females. We want to know the *how* of the matter.

The subject has been very popular. A generation or more ago Drélincourt counted some 500 dead theories of sex-determination, and his theory along with a trail of successors long since has gone to swell the number. It would be unnecessary to mention these speculations here, were it not that their ghosts are so hard to lay. One meets them time and again in modern publications whose authors ought to know better. There may be germs of truth in some of them, but any spark of life they have is usually so choked with falsehood and ignorance that the theories are doomed from the beginning.

The advantage of most of these hypotheses, from the standpoint of the originators, was the difficulty of putting them to a critical test. Thus they were useful longer than would otherwise have been the case. The idea that the two sexes were controlled individually by the right and left members of the paired reproductive glands was practically useless. Being verifiable, it was killed by the first facts obtained. Let a man with an inferiority complex get started with a compensatory notion of male superiority, on the

other hand, and his theory was hard to refute. Queerly enough, though, in the majority of such theories, the most highly developed sex, the mentally superior sex, or the physically vigorous sex, which were males of course, was nearly always supposed to produce the opposite sex in proportion to its assumed superiority. No doubt the originators were blessed with large families of girls. Conversely, Girou, who identified the sex of the offspring with that of the most vigorous parent, must have wished to congratulate himself over a preponderant lot of boys.

We now know that sex in the higher animals is largely a matter of heredity, and is usually determined irrevocably by the kinds of egg and sperm which meet at the time of fertilisation. Unfortunately, the word *usually* must be used to qualify the statement, as will be seen later.

The first piece of real evidence on the subject came from a study of human twins.¹ Two kinds exist. There are fraternal twins who look no more alike than other members of the same family. About half of the time they consist of two boys or two girls, the other half of the time there is a boy and a girl. Then there are identical twins, whose features and mannerisms are remarkably alike, and these are always of the same sex. Fraternal twins result from the fertilisation of two ova by two sperms, as is shown by the separate sets of membranes enclosing the embryos. Identical twins, since they are both enclosed in one set of membranes, must have their origin in the separate development of two segments produced by a single fertilised ovum. Where development is not wholly separate, such bizarre creatures as the Siamese twins are formed. It is difficult to imagine how such results could have come about unless sex were determined at fertilisation. If it were otherwise, identical twins should consist of a boy and a girl just as frequently as fraternal twins.

¹ Two excellent books on twins are *The Biology of Twins* (1917) and *The Physiology of Twinning*, by H. H. Newman (1923). Chicago University Press.

In the early part of the present century, when the study of heredity by controlled matings became the popular mode of research in biology, another bit of support to this idea appeared. When an individual, hybrid for a single pair of character-determiners, is crossed back with the recessive parent, the resulting progeny are half of the dominant and half of the recessive type. Thus $DR \times RR$ gives $DR \times RR$. By analogy one could not avoid suspecting that one of the sexes is similarly a hybrid producing two kinds of germ-cells, and the other a pure type producing germ-cells all of one kind, since the sex ratio in so many animals is very close to equality. Several slightly different hypotheses were published interpreting sex in this way, but the first direct proof was put forward by Doctor C. E. McClung,¹ of the University of Pennsylvania, in 1902. A few years earlier a German investigator had noticed an unpaired chromosome in half of the sperm-cells of certain insects he was studying. He reported the matter, but thought little of it. McClung now found the same feature in the reproductive cells of various insects, and suggested that this odd chromosome element was the sex-determiner.

Other American cytologists then began to investigate numerous species of animals, and corroborated McClung's observations in wholesale fashion. In most insects, in many worms, and in all mammals studied, including man himself, the male was the sex-determiner. Half of the sperm-cells contained this sex chromosome, which became known as the *X* Chromosome, and half were without it. The egg-cells all contained it. When a sperm carrying an *X* chromosome fertilised an egg, a female was produced who had two *X* chromosomes in each of her body-cells. When a sperm having no *X* chromosome entered into fertilisation, an individual was formed with only a single *X* of maternal origin in the body-cells, and this individual was a male.

¹ C. E. McClung. "The Accessory Chromosome Sex-Determinant?" *Biol. Bull.*, 3, 1902.

In some instances the X chromosome was found to be an unpaired element which, at the maturation of the germ-cells, passed to one of the daughter cells undivided. Its behaviour, therefore, could be studied easily. In other species the X had a mate, a Y chromosome; but even then the behaviour of these particular elements during the formation of the germ-cells was different from that of the other chromosomes. As if conscious of the importance of the rôle they played, they often hung back during cell division, joining their sister chromosomes at a slightly later stage. The entrance and exit of star performers belonged to them, and they took it.

Here then are several great groups of organisms where the male controls the sex by virtue of producing two kinds of sperm. The female is a passive actor, for all eggs are alike. But Nature showed no favouritism. She gave the female an opportunity to show her efficiency at this performance in moths, butterflies, and birds. There the sperms are all alike and the eggs are of two kinds. The determination of sex thus comes about in essentially the same old way.

If sex control is a chromosome function¹ similar in character to the chromosome control of other inherited traits, body qualities ought to be found that are transmitted by the particular chromosome which determines maleness and femaleness. Such a situation has been discovered, not once but a hundred times. In man, for instance, there are two recessive characters, a blood abnormality called hemophilia and colour-blindness, where the affliction is more common in males than in females, and where the hereditary transmission is peculiar. They are not transmitted from father to son, nor do they appear in the son's descendants; yet the daughters of an affected man, though normal themselves, transmit the abnormality to half their sons.

¹ See *Heredity and Sex*, by T. H. Morgan. Columbia Univ. Press, 1913. It contains a fuller description of these matters as well as a nearly complete bibliography.

This exceptional type of inheritance is understandable if the determiners of the traits are assumed to be located in the *X* chromosomes, since the distribution of the latter parallels their own distribution. When a colour-blind man has children by a normal woman, the sons are normal because their *X* chromosomes come from their mother. The daughters are also normal because the normal *X* chromosome inherited from the mother dominates the defective *X* chromosome inherited from the father; but these daughters will have defective sons whenever those sons get their *X* heritage from a defective egg, because sons are dependent entirely on the mother for their *X* heritage.

A similar type of crisscross, sex-linked heredity naturally ought to be found, and is found, in birds, where the female is the controller of sex. The best known case is a dominant character, barred feathers, such as are found in the Plymouth Rock. When a Barred-Rock cock is mated with a hen of a black breed, the offspring of both sexes are barred; but these in turn produce progeny in which half of the hens are black, though all the cocks are barred. The reverse cross, a black cock mated with a Barred-Rock hen, gives barred cocks and black hens, and these when mated together produce barred individuals and black individuals of both sexes in equal numbers. Any one ought to be able to work out the way the inheritance goes after the explanations given above. Crisscross inheritance is an easier puzzle than one of crisscross words.

In all the higher animals which have thus far been investigated, sex appears to be determined at fertilisation by the particular chromosome inheritance received. Yet it is well to be cautious. There are still a great many unsolved problems connected with the subject. Sex, in fact, is a precarious proposition; just when one thinks it is mastered, he finds that he is mistaken, as St. Anthony discovered long ago.

In man the sex ratio varies from 104 to 108 males for

every 100 females. We would like to know why, but as yet we have not the slightest inkling of the truth. Under the chromosome theory there ought to be an equal number of male-producing and of female-producing sperms, and if there is no differential viability of fertilising power between them, the sex ratio ought to be equality. But one must face the facts, and the truth is that there is an excess of males born alive among the people of every race. And if premature births only are considered, this excess is sometimes as high as 50 per cent.

Possibly equal numbers of each sex are produced at fertilisation, and a considerable proportion of the females eliminated at early stages of gestation because they find this particular portion of the life cycle difficult to pass. Such an assumption would account for the disproportionate number of males at later ages, and also, from the early elimination of feeble females, for the fact that the so-called weaker sex is really the stronger sex and has a lower death-rate from birth to old age. The theory is submitted here because it is worth investigating, and it is thought that some of our readers may possess the necessary data to confirm or to refute it.

Slight differences in the sex ratio which can be accounted for by selective elimination of the weaker sex do not disturb the view of sex-determination through the chromosomes very seriously, but what is one to say of the experiments of Richard Hertwig¹ and Miss Helen King?² Hertwig obtained as high as 100 per cent of male frogs when he delayed the fertilisation of frog's eggs until they were overripe and had taken up large quantities of water. Conversely, Miss King obtained 80 per cent of females, with a mortality of only 6 per cent, by lowering the water content of the eggs of toads.

¹ R. Hertwig. "Über den derzeitigen Stand des Sexualitäts problems nebst einigen Untersuchungen." *Biol. Centr.*, 32, 1912.

² H. D. King. "Studies on Sex-Determination in Amphibians." *V. Jour. Exp. Zool.*, 12, 1912.

Miss King¹ also obtained some very strange results in an experiment with a strain of white rats in which the sex ratio is normally 105 males to 100 females. By selection, a male-producing strain was originated in which the sex ratio was 122 males to 100 females. Selection in the reverse direction, on the other hand, resulted in a strain of female-producers in which the sex ratio was only 82 males to 100 females.

Not less confusing are the experiments of Riddle with pigeons and of Goldschmidt² with the gypsy-moth.—In pigeons more or less complete sex reversal apparently can be forced by changing the environmental conditions after fertilisation has taken place and development begun. Goldschmidt has even found strong-male and weak-male, and strong-female and weak-female races of the gypsy-moth, in which the various possible matings give different results in both the primary and the secondary sexual characters of the progeny.

Still more of an enigma is a remarkable case of sex reversal reported by Crew³ in Scotland. It is an authentic case of "functional" sex change occurring in poultry. The word functional should be emphasised, because numerous instances of superficial changes in the sex organs have been found among human beings, but in no case has an individual become both a father and a mother. The facts are as follows: A hen which had laid eggs and hatched chicks from them, later took on the appearance and behaviour of a cock. Mated with a hen, the erstwhile mother became the father of two chicks, one a male, the other a female. A post-mortem examination showed that the ovary had been destroyed by a tumor and male organs had developed.

¹ H. D. King. "The Sex-Ratio in Hybrid Rats." *Biol. Bull.*, 21, 1911.

² The points of view of Riddle and of Goldschmidt are given in *The Mechanism and Physiology of Sex Determination*, by R. Goldschmidt, translated by W. J. Dakin. London, Methuen, 1923.

³ F. A. E. Crew. "Complete Sex-Transformation in the Domestic Fowl." *Jour. Heredity*, 14: 361, 362, 1923.

These data are somewhat contradictory, it is true. But one must expect contradictions. Life is complex. What we must hold fast is that the two sexual states, maleness and femaleness, are not mutually exclusive. They are quantitative characters like many others with which the geneticist has to deal. The germ-cells in numerous species have become male-determiners and female-determiners respectively in the sense that they have inherited qualities which in ordinary circumstances hold the balance of power in the control of sex. Generally speaking, they cast the deciding vote; but there may be a recount.

Perhaps an illustration will make our meaning plainer. One may think of men or of women as possessing attributes both of maleness and of femaleness. The controlling power which makes one actually a man and the other actually a woman is the inherited constitution. The possessor of one X chromosome is a man, the possessor of two X chromosomes is a woman. And this chromosome distribution has so far shifted the balance of conditions that no environmental changes can reverse it. In some of the lower animals the balance of the sex complex is not shifted thus far by the particular inheritance received. Under extraordinary circumstances, conditions may be such that the sex is really changed.

In these lower forms where the influence of external conditions is relatively great, there is still a considerable possibility that man may be able to control sex at will. The possibility is slight, but the hope is there. That man will even be able to control the sex of his own offspring is improbable. The possibility remains, like that of making gold, but the chances weigh heavily against it. And to tell the truth, the first is about as undesirable as the second. The one would result in a terrible economic muddle, the other would bring about a social chaos.

There is, as we have seen, a plethora of evidence that the principal determinant of the characters of all animals and

plants which reproduce sexually is the chromatin. Because chromatin is distributed in a particular manner at reproduction, inheritance is what it is. In other words, the ordinary mechanism of heredity is furnished by sex. And now, paradoxically enough, sexuality is found to furnish the means by which the two sexes inherit their differences. The evidence which has been cited is only a fragmentary sample. Direct experimental proof has been made on dozens and dozens of species. Is there, then, good reason for doubting Thomases to be sceptical of the philosophy of genetics, and to equivocate concerning its application to human affairs?

Do these genetic ideas of sex throw any light on the ever-popular question as to the relative capacity of man and woman? It seems to me that they do. The heritage of the female is precisely that of the male in 46 of the 48 packets of genes which each possesses. The distinction between them is that the female possesses two *X* chromosomes, while the male possesses one *X* and one *Y*. It is possible that the extra *X* does something more than make its possessor a female, but this is not genetically probable, for usually one member of a pair of chromosomes functions as well as, and similar to, both members of the pair. It is likewise possible that the *Y* chromosome possesses other functions than that of giving maleness to its possessor, but no such additional duties have been demonstrated except in the case of certain fishes.

Man and woman are different. Yes. Havelock Ellis¹ has demonstrated that the differences in the sex glands and the hormones they release produce radical alterations of the whole structure. Woman is different from man from the crown of her head to the soles of her feet, but presumably all of these distinguishing marks are merely sex. There is no crucial evidence that either is more capable than the other in logical thinking or capacity of making intelligent

¹ Havelock Ellis. *Man and Woman*. New York, 5th ed., Scribners, 1914.

adjustments in life. It would be odd if there were a psychological differentiation other than one useful in the matter of reproduction and care of the young, for Nature is not usually careless and purposeless.

What then are we to make of the historical fact that men have done more creative work than women? How are we to interpret the undeniable truth that men have furnished the great constructive geniuses? Emotionally, women are great; witness the long roll of celebrated actresses ending with Bernhardt and Duse. But there are no philosophers among women. And in science and the arts there are few names to conjure with. The work of Madame Curie is not to be compared with that of Rutherford, though their special interests have been the same. Women inventors are rare, and are distinctly below the highest grade. Madame Le Brun and Rosa Bonheur make a sorry showing beside Rembrandt and Velasquez. Even the great designers of women's clothes have been men, as has often been noted with great glee by militant males.

I cannot persuade myself that these specific data are decisive. It may be that women labour under a physiological handicap which makes it more difficult for them to do sustained constructive work of the highest type. Their part in weaving the thread of life is overheavy. But it is doubtful whether woman's specialisation as potential mother or that considerable part of her life devoted to actual motherhood means any more than a comparative lack of opportunity for other pursuits. The tyranny of old folkways has kept her out of competition with men. If we could make a true comparison of the eminence attained by men and women in proportion to their opportunities, the story might be quite different. Think of the millions of men entering the crafts, the tens of thousands entering the arts, the thousands entering the sciences. How many of them attain prominence? Naturally, very few. Similarly estimated, particularly if relative opportunity for training is given due

weight, it is possible that women would show a record of past greatness in as high proportions as have men.

In the future, men had best look to their laurels. Customs are changing. Opportunities are increasing. More and more women are entering the world arena. And Terman's studies¹ appear to show that they are just as capable as their brothers.

¹ L. M. Terman *et al.* *Studies of Genius, I. Mental and Physical Traits of a Thousand Gifted Children.* Stanford University Press, 1925.

CHAPTER VI

THE INHERITANCE OF HUMAN TRAITS

IN one of W. M. Wheeler's jovial warnings¹ against biological dream-fancies, the ancient legend of Antæus serves as the tuning-fork. It strikes the key-note. Antæus was the huge first-generation hybrid between Poseidon, the Sea, and Gaia, the Earth, who insisted upon wrestling with every stranger invading his Libyan domain, and who remained invincible in these encounters because he gained in strength at every successive contact with his Mother Earth. He was slain at last by Hercules, who, having discovered the secret of his power, raised him aloft and strangled him in mid-air. "We may," says Wheeler, "interpret this exploit of the sun-god Hercules as a mythical expression of the fact that no terrestrial substance can permanently resist evaporation or volatilisation by heat, but the accepted and, I believe, more manifest meaning of the myth is that even an agile and vigorous mortal had best keep his feet on the concrete if he wishes to avoid death at the hands of the Hercules of abstraction."

Most of us do have an abiding distaste for the abstract, since without sanction of philologists or lexicographers the term has become a boggy, carrying with it the idea of something vague, dubious, insubstantial. But by right we ought to treat it with respect and consideration, for the abstract is merely the general, and the generalisations of inductive logic constitute the complete record of mankind's intellectual progress. Presumably we realise that we are not all gifted with Newtonian or Darwinian minds, and, distrusting the soundness of our mental operations, we ask for an excess of concrete examples before drawing conclusions.

¹ *Science*, 57: 61-71, 1923.

As a sacrifice to this psychological goblin, a number of examples of human heredity will be discussed to serve as reinforcement for the generalised philosophy of genetics. It is a weak submission to expediency, but let that pass. It is no trouble to show samples, though one must not suppose that they represent adequately the goods in store. The available evidence, codified and analysed by trained men, amounts now to several thousand volumes.

It is fairly arguable that every trait by which people differ, aside from minor fluctuations caused by environmental dissimilarities, has its heritable basis. It is not so ridiculous as it may seem to see a dim influence of heredity even in a fire-scarred face or an amputated finger. The individuals who carry these records of unfortunate experience will not transmit their acquirements. They are not hereditary in this sense. But why was the first urchin trying to set fire to a chicken-coop, or the second endeavouring to build an aeroplane, when their guardian angels were not looking? Something besides the imitative, beyond the exigencies of the immediate situation, was involved here. These boys were differently endowed.

Such an example may be beside the point, far-fetched. I do not know. I can only say that the longer I study heredity, the less forced it seems. In comparison, let us take another case, longevity. Is length of life inherited? The usual answer to this question dictated by common sense is affirmative, but with numerous senatorial reservations. The reasoning is thus. Essential organ systems must differ, like chins and noses; and if they do, some of them must wear out sooner than others. We cannot all be cut from the pattern of the One-Horse Shay. To this extent heredity must play a part in determining the length of life. But diseases are not hereditary, and accidents are accidents—matters of mere chance. One cannot quarrel vehemently with this idea. It presents the legal aspect of the case fairly enough; but it is superficial. Diseases caused by the inva-

sion of battalions of parasites are not inherited, that is true; nevertheless, heredity is a major factor both in defending the breastworks against assault and in repelling boarders. And accidents are not altogether due to chance. A great manufacturing company kept a record of the accidents occurring during a given factory operation where large numbers of unskilled men were employed. The results were segregated according to the racial origin of the men, and were tabulated and compared, giving due weight to the proportion of the races thus exposed to risk. The upshot was that there appeared to be an intelligent and careful race, a careless race, a reckless race, and a stupid race. In spite of the fact that there must have been great differences between individuals within each race, the apparently stupid race was involved in six times as many accidents per thousand exposed to risk as the apparently intelligent race. Was no heredity involved here?

On this matter of longevity extended studies have been carried out by Karl Pearson¹ at the Francis Galton Eugenics Laboratory in London. His method of analysis was to measure the association between parents and offspring for "age at death." This measure of association, or correlation, between the two generations is a single arithmetical term taking the form of a fraction. If the age at death of the parents has no effect on the age at death of the offspring, because heredity has no influence, the determination will be zero; if heredity does exert a measurable influence, determinations will lie between zero and unity. The average correlation between parents and offspring proved to be .1365. This figure means little, however, unless one has similar computations from characters known to be inherited with which to compare it. Fortunately, Pearson has made a large number of such studies upon physical measurements,

¹ Cf. particularly, M. Beeton and K. Pearson, *Proc. Roy. Soc.*, 65 : 290-305, 1899; and *Biometrika*, 1 : 50-89, 1901. Also, K. Pearson, *The Chances of Death*, 2 vols. London, 1897.

and has found that the average correlation between parent and offspring is .4675. This figure, computed for a series of characters comparatively unaffected by differences in environment, may serve as a yardstick for duration of life where it is admitted that all sorts of accidental circumstances affect the result. Comparing the two by a method of his own in which certain necessary corrections are made, Pearson reached the conclusion that from 50 to 75 per cent of the general death-rate is determined solely by the forces of heredity, and is not susceptible of modification by progress in practical sanitation and preventive medicine.

One of the best investigations of this type is the work of Alexander Graham Bell¹ based upon the lives of nearly 2,300 persons belonging to the Hyde family. Using a simple, common-sense method of analysis which proved thoroughly satisfactory, Bell discovered that when neither parent lived to be 80, only 5.3 per cent of the offspring reached this age; where one parent lived to be 80, 9.8 per cent of the offspring reached this point or older; where both parents attained their 80th birthday, 20.6 per cent of the offspring arrived at the same great age. Thus it was shown that much the best way of obtaining a patriarchal status is to select long-lived fathers and mothers—both if possible.

The commoner traits by which people differ—body, form, weight, strength, stature—are to a great extent hereditary; but so many genetic factors are involved in each, the results of specific matings cannot be predicted with any high degree of accuracy.

Some families lay on fat with the ease of Aberdeen-Angus steers; others utilise the excess energy of their food in other ways and remain as thin as timber-wolves. The only definite genetic statement permissible is that the children of fleshy parents are somewhat more variable than the children of slender parents. Obesity tends to be partially dominant.

¹ A. G. Bell. *The Duration of Life and Conditions Associated with Longevity*. Washington, privately printed, 1918.

Similarly, there is evidence of partial dominance of shortness. The progeny of short parents tend to be more variable than the progeny of tall parents. Numerous genetic factors probably govern these differences, but short people are more likely to have tall children than tall people are to have short children. Stature is naturally influenced by nutrition, though it is the kind rather than the amount of food which produces the effect. Osborne and Mendel¹ have been able to keep rats from developing beyond the flapper stage by giving them rations that were perfectly balanced except for the omission of one or two of the amino-acids from which proteins are re-constituted; and it is quite likely that similar results could be obtained from human beings. But evidence continues to accumulate that the true arbiters of stature are the genes. In fact, the hereditary nature of body size has been recognised for so long that one is scarcely surprised to read in Prussian history how Friedrich Wilhelm I planned to produce a race of tall soldiers by marrying a selected lot of grenadiers to tall women. He died before he could carry out his scheme, but Catherine de Medici did try a similar experiment. She promoted unions between dwarfs with the object of producing a dwarf race, and undoubtedly would have succeeded had it not happened that these particular matings were sterile.

Dame Nature was more successful than the wily daughter of Lorenzo of Urbino. Several tribes of little men are hidden around in various parts of the earth—the elves and gnomes of early tradition. Averaging 4 feet 6 inches in height and 75 pounds in weight, they are 15 inches shorter and one-half the weight of the larger races of mankind; but they are not true dwarfs. What little information we possess about the results of matings between the Central African Negrilloes and their normal-sized neighbours the Bantus—and meagre enough it is—leads us to believe that the differences between these two extremes are controlled by a considerable number of more or less independently inherited

¹ Various papers chiefly in the *Journal of Biological Chemistry*.

genes which exhibit little or no dominance, precisely as the size differences between flowers and melons and rats and dogs are seen to be controlled in the experimental matings of the genetic laboratory. Dwarfism, on the other hand, is inherited in a rather simple way, as if it were the result of serious derangement of function in one or two special genes.

There are three main types of dwarfs—cretins, achondroplasts, and ateliotics. The cretin is a ghastly example of what may happen when a gene loses the power of performing its appointed task; for cretinism is inherited as a simple recessive; it is the loss of one cog in man's intricate machinery. The thyroid does not function, and the result is a Thing, with little body and no mind. The other dwarfs possess minds approaching the normal, though ateliotics usually remain more or less childish. Achondroplasts have normally proportioned torsos and short arms and legs. They are often fertile, and some of the progeny nearly always reproduce the characters of the abnormal parents. The genetic interpretation is that here is a dominant abnormality which inhibits growth, but in which the effect is sometimes cancelled by other inherited factors. Ateliotic dwarfs, which are normally proportioned human miniatures, seldom have children; and when they do, the resulting data are conflicting. That the condition is hereditary is perfectly clear, but in some cases the gene seems to produce a dominant effect, and in other cases a recessive effect. Perhaps ateliotics are genetically of two kinds.

Thus there are two kinds of genetic difference producing variations in size. What may justly be called ordinary variation is the result of numerous unlike genes which, nevertheless, function so as to produce a harmonious whole; dwarfism, on the other hand, is the result of defectiveness in one or two particular genes. Dwarfs, therefore, may also show ordinary individual variation due to normal genetic differences. In this the human race is exactly like other animals and vegetables. In Indian corn, for example, there is a tremendous

number of genetic differences bringing about the variations in size characteristic of the ordinary agricultural varieties, but there is also a limited number of genetic defects causing true dwarfism.

The primary effect of the genes causing human size-differences is still somewhat of a mystery, though it is known to be intimately connected with glandular secretion. If this should prove to be the whole story, the secondary effect, that upon the body as a whole, may ultimately be mitigated or even cancelled by treatment. The advent of such methods would be in the nature of a mixed blessing, fine for the otherwise defective individual but rather serious for the race. It does not seem to me that one should make a special object of insuring fertility among dwarfs; their germ-cells would still remain abnormal.

At any rate, it is a long road to this bridge. There are so many internal secretions, and they all seem to have an effect upon body size. Women are probably shorter than men because they mature earlier, since shortly after sexual maturity growth ceases. Insufficient thyroid secretion produces changes of various kinds. Cretinism is the extreme. Excessive activity of the little pituitary body situated at the base of the brain promotes gigantism; insufficient secretion prevents development and delays or prevents the functioning of the sex glands. And similar effects are produced by hypertrophy or atrophy of the pineal body.

In addition to these cases where the whole skeleton is affected by a defect in a single gene, there is a long list of skeletal abnormalities in which only a special part is affected in a noticeable degree. Many of these conditions are dominant to the normal, which is not a common phenomenon where abnormalities are concerned. Among them are extra digits, short digits, fused digits, and several other malformations of the hands and feet. They are not such terrible afflictions as some others, but still they are not the most desirable possessions in the world; so it is just as well they

are dominant if they are to be inherited at all. The recessive abnormalities are the curses of mankind. With recessives one cannot tell when they are going to crop out; with dominants one may rest assured that a normal person from an affected strain is free from the stigma in all his germ-cells. There may be certain recessive skeletal defects, but they are probably not very important or we should have been able to collect pedigrees enough to determine the matter before now. And the same remark may be made for some of the congenital muscular anomalies. Thomsen's disease, a lack of response on the part of the voluntary muscles, and some rare and little understood muscular atrophies, are clearly inherited defects; but they are so rare that sufficient evidence for an adequate analysis of the method involved is still lacking.

Incomplete development of the reproductive organs is a condition difficult to imagine as being hereditary. Such defects ought, theoretically, to be eliminated almost as soon as they originate because of the tendency for affected persons to be sterile. Nevertheless, long pedigrees exist in which individuals having genital abnormalities appear in every generation. Cryptorchism, retention and atrophy of the testes, is one. Prolapsus of the uterus is another, though it must not be understood that all cases of uterine prolapsus are hereditary. It is never transmitted by the affected females, for they are sterile; the condition is maintained by transmission through the male. Hypospadias, an imperfect sexual dimorphism, is also hereditary. Lingard collected evidence of transmission through six generations in one family.

Hereditary derangements of metabolism are common. Diabetes insipidus is a case in point. Diabetes seems to be a dominant. Where the condition is genetic, the diabetic must have had at least one affected parent. Unnatural conditions of the excretory organs, which are of course the result of disordered metabolism, are additional examples.

Garrod found that Alkaptonuria is apparently a recessive trait. Cystinuria and Hematuria are also hereditary, though they are so rare it is difficult to say just how they are transmitted. An hereditary tendency to gout has been recognised for several centuries.

Susceptibility to respiratory diseases, as well as certain cardiac weaknesses, run in families. And several distinct blood defects are transmitted, either as dominants or recessives. Perhaps the most interesting of these conditions, from the genetic view-point, is hemophilia. Persons affected with hemophilia are known as "bleeders." Their blood is deficient in the chemical causing clotting, and for this reason hemorrhages are controlled only with great difficulty. Its peculiarity is that it is one of the few human variations known to be carried as a recessive in the sex chromosome. Since a male receives his single sex chromosome from his mother, an affected father cannot transmit the condition to a son. Nor will the daughters of an unaffected male be "bleeders" unless the mother is a heterozygous normal carrying the taint in half her germ-cells. But the daughters of an affected man, though his mate is normal, will transmit the condition to half their sons, no matter whom they marry. For a long time it was supposed that females could not exhibit hemophilia, but Doctor J. H. Stick¹ has charted a five-generation pedigree of a Maryland family in which nine affected females appear. They are the result of matings in which the male is affected and the female is a carrier.

Several other hemorrhagic diseases, such as epistaxis and telangiectasis, are thought to be simple dominants. Within the group of blood diseases known as anemias there is also evidence of an hereditary trend. Chlorosis, a rather common and distressing malady, is usually found only among females, though males do not escape entirely. Genetically

¹ Cited by C. B. Davenport in *Heredity in Relation to Eugenics*. New York, Henry Holt, 1911.

this is an odd and interesting phenomenon and should be studied carefully.

The inheritance of normal eye-colour was described in a preceding chapter. It would be a blessing if the geneticist could stop there and close the book. But the vertebrate eye is a delicate mechanism. It would not be worth much otherwise. One must expect, therefore, to find numerous cases of defectiveness. The machine isn't always turned out with the required perfection.

Several anomalies of the eye are due to recessive defects carried in the sex chromosome, the method of transmission being identical therefore with the one described for hemophilia. One of these conditions, colour-blindness of the type where red and green appear to have the same shade, is annoying but not a grievous burden. It is rather common, Davenport stating that 4 per cent of the men and one-half of 1 per cent of the total inhabitants of Europe are affected. The difference in frequency for the two sexes is due, of course, to the fact that females must be homozygous for the trait if they are to exhibit it. The other two sex-linked deficiencies, atrophy of the optic nerve and night-blindness, are serious afflictions, but fortunately are rather rare. Atrophy of the optic nerve results in total blindness from which there is no recovery; night-blindness (hemeralopia), which, at the beginning, is simply an inability to see by artificial light, is also progressive and usually ends in complete blindness. For night-blindness we have the longest pedigree ever compiled by students of human heredity. It is the record of a European family completed to date of publication by Currier in 1838, and continued by Nettleship¹ in 1907. It contains a record of over 2,000 persons.

Coloboma, a defect which usually shows only in the iris but may affect the lens, the retina, and the choroid coat, possibly should be added as a sex-linked condition to the

¹ E. Nettleship. *History of Congenital Stationary Night-Blindness in Nine Consecutive Generations*. Ophth. Soc. Trans., 27: 269-293, 1907.

three abnormalities just described. In none of these four anomalies, however, is it certain that a single type of defect is always involved. Some pedigrees have been compiled where the condition appears to be a simple recessive not sex-linked, and in the case of colour-blindness, at least one family has been found where dominance is indicated. Attention is called to these facts, for they are important. They show that diseases with identical symptoms may be caused by mutations in *different* genes.

Other serious eye defects where the evidence of inheritance is clear are cataract, degeneration of the cornea, dislocation of the lens, glaucoma or excessive production of the eye-fluids, nystagmus or swimming eye, megalothalmus or protruding eye, pigmentary degeneration of the retina, astigmatism, myopia, ophthalmoplegia or paralysis of the eye muscles, etc. Some of them have been studied intensively. Loeb, for example, compiled the pedigrees of 304 families in which congenital cataract has been found. Of the 1,012 children in these families, 589 were affected, though cataract is an affliction which often comes on late in life. Loeb¹ also found 42 pedigrees of families in which there was displaced lens (ectopia lentis). Of the 150 children investigated, 70 per cent were affected. It is not always possible to study these matters as thoroughly as might be desired, however; the disease may be rare, it may be difficult to diagnose, it may be an old-age defect, it may be a condition which families endeavour to conceal. And, in addition, some defective conditions, like myopia and astigmatism, probably include a whole series of different abnormalities. They are general terms serviceable to the physician, but a motley array to the geneticist.

The fact that exact medical records of defectives are rare even where anatomical knowledge is adequate accounts for much of the difficulty which geneticists experience in analys-

¹ C. Loeb. "Hereditary Blindness and Its Prevention." *Ann. Ophth.*, Jan.-Oct., 1909.

ing data. They are not to be blamed, therefore, for their seeming lack of progress along certain lines. In reality they are hard-working persons. Take as an example the matter of deaf-mutes. Deafness is so often clearly congenital that many countries have forbade the marriage of affected persons. And Fay,¹ some 30 years ago, collected data on 335 matings of the deaf, 25 per cent of which resulted in the appearance of some deaf offspring. The total progeny numbered 779, and of these 26 per cent were deaf. Yet, as Davenport² says, the method of inheritance remains obscure, and because of this, some few rather ignorant sceptics have denied that heredity plays any rôle whatever. Why this state of affairs? Why is it so difficult for geneticists to say precisely how congenital deafness is transmitted? The reason is simple: deafness is a generic name for a veritable hotchpot of disorders which probably have little relation to each other. There may be a dozen kinds of hereditary deafness: some may be simple dominants, some simple recessives; some may be sex-linked, others may be the result of the interaction of several genes. All we know is that many types of deafness are hereditary, and that those which are transmitted must be transmitted through the chromosomes by their ordinary means of allocation. Listen to what Politzer gives as the anatomical causes of congenital deafness, as quoted by Davenport (1911): "Impaired development or absence of middle ear; defects and rachitic deformities of the labyrinthine windows; narrowing of the recess of the round window to a cleft, with connective tissue; atresia of the same; atrophy of the cochlear nerve and spinal ganglion in the first turn of the cochlea; abnormalities of the membranes of the otoliths, organ of Corti, and ductus cochlearis; faulty development of the sensory epithelium; defects of the crista and sulcus spiralis; lack of development of the labyrinth and of the auditory nerve; malformations of the central nervous system." What a potpourri this is!

¹ E. A. Fay. *Marriages of the Deaf in America*. Wash., Volta Bureau, 1898.

² C. B. Davenport. *Heredity in Relation to Eugenics*, l. c.

Ordinarily we think of the epidermis as the first line of defence protecting the body from bacterial invaders—a fair description of its function. But morphologically the organs of ectodermal origin include some highly differentiated and specialised parts. Besides the hair, the sweat glands and the sebaceous glands, there are the nails, the teeth, and the mammary glands. All of these organs exhibit variations, many of which are hereditary. There are half-a-dozen disorders of the skin showing some indication of either a true abnormality inheritance or a transmission of susceptibility to parasites. Then there are hair defects and nail defects, which often appear to be associated. Supernumerary mammaræ are also common. But of all the epidermal irregularities, those of the teeth occur most frequently. Genetics studies have not been very intensive in this field as yet, so we cannot describe the precise mode of inheritance of any one of them, but they are interesting as showing what insignificant details can have a separate hereditary basis in the germ-cells.

Some of these teeth abnormalities are so generally distributed among certain peoples that they are practically racial traits. Faulty enamel among the Irish is so noticeable as compared with the splendidly enamelled teeth of Italians that many dentists are inclined to attribute the difference to food habits. The argument against this conclusion is the persistence of the respective characteristics after emigration to the United States, where the newcomers soon set up dietary standards that are much alike except as the starch intake is in the form of potato in the one and in the form of spaghetti in the other.

Davenport records a complete set of double teeth as a family trait, though all the dentists of my acquaintance shrug their shoulders at the possibility. Congenital non-eruption, on the other hand, is well authenticated. So also are variations in number, size, shape, and marking. The dental formula for man is two incisors, one canine, two bicus-

pids, and three molars. Queerly shaped incisors, additional canines, omitted molars, anomalous bicuspid and peculiarly formed cusps, serve to vary the monotony, however. In fact, the correction of abnormally formed jaws and teeth is a distinct branch of the dental art; and every well-informed dentist who practices it admits that if it were not for the prevalence of these conditions in certain families, he would have to hunt for another vocation.

What one may call the normal variations of epidermal organs are hair form, hair colour, and skin colour; and these are precisely the variations upon which anthropologists earlier based their racial classification. Each of these three characters is controlled by several genetic factors, but there is a slight difference in their hereditary behaviour. In hair form and colour there is a tendency towards dominance, in skin colour dominance is absent, or at least negligible, according to Doctor and Mrs. Davenport,¹ to whose labours we owe most of our genetic knowledge of these traits.

Hair varies from straight to woolly, depending on whether it is circular or flattened in cross-section. Straight hair is the recessive condition. Straight-haired parents always have straight-haired children. Wavy-haired progeny from matings of this type have occasionally been recorded, but no great weight is to be attached to these exceptions because of the difficulty of obtaining precise classification and of the relative frequency of errors as to paternity. If curly hair is designated *CC* and straight hair *cc*, then *Cc*—the heterozygote—has wavy hair. Matings between wavy-haired persons and straight-haired persons result in progeny about half of whom have straight hair and half wavy hair. Woolly hair is probably due to the possession of one or more genes which “flatten” the hair to a still greater extent than does the *C* gene.

¹ C. B. Davenport and G. C. Davenport. “Heredity of Skin Pigmentation in Man.” *Amer. Nat.*, 44: 641-652, 1910. See also C. B. Davenport, “Heredity of Skin Color in Negro and White Crosses.” Publ. Carnegie Inst. No. 188, 1913.

The heredity of hair colour is more complex than that of hair form. Without taking into consideration a possibly numerous lot of genetic factors which modify the colour expression in a slight degree, the available data can be interpreted by the distribution of three brown-pigment genes and one red-pigment gene. There is something queer about the appearance of red hair. It is clearly recessive to black and brown, but crops out especially frequently in families ordinarily characterised by *glossy* black hair. Red, however, may be present or may be absent in families marked by the possession of the black-brown series of genes. Heterozygous matings, therefore, will produce some flaxen-haired individuals if red is absent, or these otherwise flaxen-haired youngsters will have red polls if the red gene is present. Flaxen hair is the ultimate recessive. It breeds true. But unions of dark-haired persons, where those persons are heterozygous, will produce a variable progeny.

In skin colour, on the contrary, the phenomenon of dominance is so inconspicuous it may be said to be lacking without committing serious error. Mulattoes are blends, blends with a rather uniform tinge. Yet the progeny of these hybrid blends show great diversity of colour. Recombination of the genes controlling the colour differences between the two races has occurred. Mathematical analysis of a large number of pedigrees of such matings shows that the genetic difference between the blackest of black negroes and the whitest of Caucasians, so far as skin colour is concerned, is three or four pairs of factors the effects of which are quite similar. The skin colour of the negro may be represented by the formula $B_1B_1B_2B_2B_3B_3$, and that of the white by the formula $b_1b_1b_2b_2b_3b_3$; the true mulatto is thus $B_1b_1B_2b_2B_3b_3$. A little study shows that the tinge of the progeny from mulatto unions may vary all the way from black to white, though intermediates will be more common. It also shows that there can be true-breeding light-brown individuals, such as $B_1B_1 b_2b_2 b_3b_3$ and $b_1b_1 B_2B_2 b_3b_3$, from whose intermarriage

will come grandchildren both darker and lighter than their grandparents.

A favourite short-story plot with which melodramatic artists seek to harrow the feelings of their readers is one where the distinguished scion of an aristocratic family marries the beautiful girl with telltale shadows on the half-moons of her nails, and in due time is presented with a coal-black son. It is a good framework, and carries a thrill. One waits shiveringly, even breathlessly, for the first squeal of the dingy infant. There is only this slight imperfection—or is it an advantage?—it could not possibly happen on the stage as set by the author. The most casual examination of the genetic formulæ given above demonstrates its absurdity. If there ever was a basis for the plot in real life, the explanation lies in a fracture of the seventh commandment, or in a tinge of negro blood in the aristocrat as dark as that in his wife.

One of the queerest cases of the inheritance of epidermal emergences is baldness. Doubtless baldness is sometimes the result of disease, though responsible physicians have presented no adequate proof. But the primary cause of baldness is neither a parasite nor a tight hat, it is a parental legacy. One who tries to put off the evil day by applications of salves, emulsions, and solutions, therefore, is merely alleviating overpopulation in Naples.

Baldness is much more frequent in men than in women, and the reason is that the condition is dominant in men and recessive in women, as has been demonstrated by Osburn.¹ If normal hirsuteness is designated by the letter N and baldness by the letter n , then the heterozygote Nn will become bald only if a male. The bald female must be nn .

This interesting type of genetic phenomenon was first discovered by Wood when investigating the inheritance of horns in sheep. Both sexes of the Dorset breed are horned; neither sex of the Suffolk breed is horned. If a Suffolk ewe

¹ D. Osburn. "Inheritance of Baldness." *Jour. Heredity*, 7: 347-350, 1916.

(*hh*) is crossed with a Dorset ram (*HH*), the male heterozygotes (*Hh*) are horned and the female heterozygotes (also *Hh*) are hornless. Obviously a hornless female of the proper genetic constitution, *Hh*, mated with a hornless male, *hh*, will transmit the horned condition, though she does not exhibit it, to one-half of her male progeny. In spite of the comedy in the comparison, baldness is similar. A bald-headed man may have received his heritage from his mother although her tresses were as long as those of the seven Sutherland sisters.

The consideration of hereditary defects in the nervous system has been held in abeyance to serve as our last topic, for disorders of this type are the most serious with which mankind has to contend, not only because of their grave consequences, but also because of their frequency. The complexities of modern civilisation cannot be unravelled by those afflicted with mentalities far below the normal. Barnum's What-Is-It, a microcephalous idiot, collected from the curious a fortune for some one, and one suspects that the payrolls of Hollywood support a considerable number of lack-wits; but in the main they are merely a dead weight cutting down the activities of the more competent members of society.

The central nervous system is such an intricate mechanism, it is not odd that it should sometimes get out of order. The wonder is that it exhibits a reasonable perfection in so many cases. Yet nervous disorders are not infrequent. And every psychosis has a physical basis, a neurosis. By no means all of them are hereditary, but hereditary tendencies have been demonstrated for a dozen or so types. We shall notice only three kinds—epilepsy, insanity, and feeble-mindedness.

These three terms are generic subdivisions of one family. Each takes numerous forms, and, in so far as pathological anatomy has presented evidence, shows different types of concurrent structural change; but many of the groups within

each genus show etiological and genetic relations to each other, as well as to the other genera.

Goddard¹ defines feeble-mindedness as a "state of mental defect existing from birth or from an early age, and due to incomplete or abnormal development, in consequence of which the person affected is incapable of performing his duties as a member of society in the position of life to which he is born." The last phrase is somewhat obscure. Apparently it means that an infant born to social leadership or to a seat in Congress would not be classified as feeble-minded; but if born to the art of plumbing or to the tonsorial profession, he would be so described. Be that as it may, feeble-mindedness has been described by the American association founded for its study on the basis of what the individual is able to learn. If his capacity for imbibing knowledge is that of the average child two years old or less, he is an idiot; if his capacity is above that to be expected of a two-year-old and below that of a seven-year-old, he is an imbecile; if his ability fits in between seven and twelve year children, he is a moron. This classification is arbitrary, but it serves a useful purpose when dealing with feeble-mindedness as a social problem. Medically and genetically it means nothing—at present.

The distinguished American authority quoted above, who compiled detailed records of 300 adequate family histories, found that 164 cases (54 per cent) were unquestionably hereditary and 71 (23.3 per cent) probably hereditary, making together 235 cases, or 77.3 per cent, having a probable hereditary basis. And this figure doubtless is too low, since the method of inheritance is such that the influence of heredity cannot always be traced, and such cases are consequently placed in the category of "accidents."

Epilepsy, or falling sickness, is an ancient disorder of the nervous system which may come on at any period of life,

¹ H. H. Goddard. *Feeble-Mindedness: Its Causes and Consequences*. New York, Macmillan, 1914.

but more frequently begins at adolescence or around the age of forty. Epileptiform conditions are caused by pressure on the brain due to depressed fractures or to the presence of tumors in about 30 per cent of the cases. These cases are usually light and are afforded relief by surgical treatment. The remainder are nearly all hereditary, and are usually due to progressive degeneration of the nervous system, and not to incomplete development. In some few patients the disease manifests itself by infrequent seizures, but according to Sir J. R. Reynolds,¹ the English authority, 80 per cent have attacks oftener than once a month. There are numerous instances where the disease seems to have no injurious effect upon the general health, but since maniacal excitement often occurs, and since the majority of cases show a progression which often ends in dementia or idiocy, it is doubtful whether these should be classed as true epilepsy.

Insanity is a still more inclusive term than either feeble-mindedness or epilepsy. Davenport says: if "epilepsy is a wardrobe, insanity is a veritable lumber room." Clinically these nervous disorders are divided into organic diseases and functional disturbances, depending upon whether or not the symptoms manifested during the life of the patient can be associated with morphological changes discoverable after death—naturally an extremely rough classification. Hereditary tendency to some of these disorders has long been recognised. Some years before genetics had taken on the aspects of a science, Tredgold, one of the most eminent of English authorities, found that 70 per cent of 150 cases of idiocy and imbecility immured in London asylums had insanity in the family in some form or another. The hereditary types of insanity include the lighter types of neurosis, migraine, hysteria, and neurasthenia, and certain of the psychoses, such as delusional insanity, mania and melancholia, maniac-depressive and periodic insanity, and dementia-præcox.

¹ See *Encycl. Brit.*, Ed. 12.

We do not know all that we should like to know about the genetic relationships between these various derangements of the nervous system; nevertheless, their genetic status is more satisfactorily established than their medical status. We owe this knowledge largely to the work of Goddard on feeble-mindedness, of Weeks on epilepsy, and of Cannon and Rosanoff on insanity; though European investigators, particularly those of Germany and England, have also contributed many painstaking analyses of family histories. Over 600 family trees have been shaken and the fruit graded and analysed. And the result is that these disorders have been found to be inherited as simple recessives. Defectiveness in a single gene accounts for the divergence between a feeble-minded and a capable child, between an insane person and one who is sane, or between an epileptic and a normal.

The concordance of results is extraordinary, the apparent exceptions hardly worth noting. For example, matings of feeble-minded individuals with each other ought to give only feeble-minded children, according to this hypothesis. Among 482 children, resulting from 144 of such unions, Goddard found 6 apparently normal children. Statistically, such a limited number of exceptions is negligible; genetically they are important, if they are exceptions. But are they? In the first place, it is not absolutely certain that these children are normal. Re-examination might show them to be high-grade morons. In the second place, one is never sure that the putative father of the child of a feeble-minded woman is the real father. Doctor Emerick,¹ of the Columbus (Ohio) Institution for the Feeble-minded, discovered two feeble-minded white parents who had ten feeble-minded and two normal children, but the feeble-minded children were white, while the normal children were coloured. Again, the results of unions between a feeble-minded parent (*nn*) and a normal heterozygote, a carrier (*Nn*), or between two carriers (*Nn* × *Nn*), are remarkably in accord with theory. They are even

¹ Cited by Goddard, *l. c.*

more closely in accord with theory than Goddard makes out in his report, for he did not make the proper corrections when calculating the expected number of feeble-minded children for (1) $Nn \times nn$, and (2) $Nn \times Nn$ matings, with which to compare the results actually obtained. The results to be expected theoretically are one dominant to one recessive for union No. 1, and three dominants to one recessive for union No. 2, when individuals of known genetic constitution can be mated like guinea-pigs in a cage. But in human records like these the genetic constitution must be determined from the result, and the criteria for assuming that a mating is one of the above types is the mental condition of the parents and the birth of at least one feeble-minded child, since such unions, resulting only in normal children, will necessarily be omitted. When the proper mathematical corrections are made in such cases, by a simple and correct algebraic method, the correspondence between theoretical expectation and actual result is so good as to be almost suspicious.

Goddard will have the sympathy of many readers when he concludes his extraordinary piece of research with the statement:

"The writer confesses to being one of those psychologists who find it hard to accept the idea that the intelligence even *acts as a unit character*. But there seems to be no escape from these figures." He has the present writer's sympathy, also. The difficulty comes from an incorrect idea of the mechanism of heredity. Intelligence does not act like a unit of any kind, but it may be destroyed by the change in a single gene. Let us consider the matter.

Mental capacity is due to the interaction of many, many genes, hundreds, possibly thousands, which work together harmoniously to produce the result we call a normal man. Yet normal men are not alike in ability. One may be able to rise no higher than a farm labourer, though some farm labourers might do honour to the Bench if given the opportunity; another may have the capacity to become a me-

chanic; another the mind of a scholar; and so on up to the highest type that the species called *sapiens* can produce. We have only to think of these differences in terms of properly functioning *yet different* genes to get a clear picture of the situation. Assume for the sake of illustration that the genes controlling intelligence number twenty-six, like the letters of the alphabet, and that each gene has mutated three times into constitutions which, while each will fit into the machine properly and do yeoman service for its possessor, will exhibit different degrees of efficiency. The difference, then, between a Leonardo da Vinci and a Richard Roe is that Leonardo's legacy was a preponderant proportion of the efficient genes, while Richard's inheritance included less than his fair share.

Now let us draw again on the imagination. Fancy one of these genes undergoing mutation to a constitution of such nature that an essential part of the mental machinery cannot be produced or is incomplete and functions badly. Result? Feeble-mindedness, or some other type of mental disorder depending on the efficiency of the particular legacy of normal modifying genes received.

Our imagery fits all the facts. It is, in truth, a strictly scientific hypothesis. The only desirable piece of information lacking is the exact *number* of *essential* genes that have mutated to a non-functioning or poorly functioning condition, and the relation between them, if more than one. And on this point we are not wholly ignorant. We know that the number must be small. The last statement has an eminently practical bearing and should perhaps be repeated in less technical English. A gene is, one must remember, a definite entity invariably carried in its appointed place in the chromosome to which it belongs. Let us assume now that an essential gene "A" in one pair of human chromosomes has changed to a functionless gene "a," and that through the proper mating an "a" egg has fused with an "a" sperm and a feeble-minded individual has come into the world.

The question then arises whether a second feeble-minded individual, or an epileptic individual, or an individual having any one of a dozen other nervous disorders, owes his condition primarily to the same genetic deficiency as the first, "*aa*," with modifying factors bringing about whatever differences from the first individual that he exhibits, or whether he owes his condition to a second deficient gene, "*bb*." The question is important. If the second assumption holds, each defective individual will possess normal mates (allelomorphs) to the defective genes possessed by the other. They will be "*aaBB*" and "*AAbb*" respectively. And the offspring from such a union will be normal heterozygotes "*AaBb*" because of the dominance of the two normal genes represented by the capital letters. If the first assumption holds, and the defective mentality is due entirely to defectiveness in a single gene pair "*aa*," then matings between such defectives will produce only defective offspring.

In Jennings's recent book, *Prometheus*,¹ he leads the reader to believe that we do not know anything about this situation. He implies that perhaps there are an enormous number of *different* defective genes, and that almost any random mating between congenital defectives will be likely to produce normals. The optimistic layman thus obtains the idea that all is well. Defective unions will produce normals. Jennings fails to explain that this hypothesis is not so hopeful as it looks. If it were true that such matings produced "*AaBb*" normals, it would also be true that matings between two individuals of the latter character would produce on the average seven defectives to nine normals. And of the nine normals only one will breed true for normalcy, as the genetic saying goes; the other eight will carry either one or both types of defective genes in their germ-cells.

But the premises of Jennings are incorrect. One fears that he allows his humanitarianism to sidetrack his usually

¹ H. S. Jennings. *Prometheus, or Biology and the Advancement of Man*. New York, Dutton, 1925.

clear train of reasoning. It is true that we do not know whether there are one or several genes producing mental defectiveness. Possibly one type of defective gene produces feeble-mindedness, a second epilepsy, a third insanity; though it must be remembered that all three of these conditions appear in records of particular families, and hence must have some relationship even if they are not due to a single genetic condition modified by other hereditary factors. It is even possible that more than one genetic condition is the primary cause of feeble-mindedness alone. But the number of such genetic abnormalities must be extremely limited. No other conclusion can be drawn from the evidence. About 300 matings of defectives with defectives have given only defectives. This means that defectiveness in only one gene has been involved. More data will be welcomed. If different heritable bases for mental deficiency exist we want to know it, but the knowledge will not change the sociological problem a whit. We already know that numerous kinds of mental defectives exist, that from 70 to 80 per cent of the cases are hereditary, that so great is the variety of mental disorders found in a single family that some genetic relationship must exist between them, and finally that the hereditary tendency is primarily the result of the action of one or of a few recessive genes, the end result being modified by the interaction of other, presumably normal, genes. What does it matter whether the recessive genes primarily responsible for defectiveness are one or ten in number?

These are our samples of the kind of evidence proving that human heredity is like any other heredity, the result of the interaction of factors carried in the chromosomes, and distributed by a chromosome behaviour identical with what is found in the plants and the lower animals. It is the same for cabbages and kings. Actual pedigrees, the documentary evidence, have not been presented. It was not the intention to write an encyclopædia. They are available

elsewhere to those who are interested. But we have cited examples of human characters transmitted in all the little peculiar ways, the discovery of which has made laboratory genetic investigations on the lower organisms so interesting—characters controlled by simple dominants and recessives, by factors which show no dominance, by factors which interact to produce a visible result, by multiple factors such as those which control size, by sex-linked factors, by the factors improperly called sex-limited, like baldness. Logically, they ought to be convincing. In numerous cases 12 good men and true have not hesitated to deliver a verdict with less to guide them.

CHAPTER VII

THE TWO COLLABORATORS—HEREDITY AND ENVIRONMENT

No genetic question has been so obscured by fantastic and absurd arguments as that concerning the respective rôles of heredity and environment in the development of men. It is essentially a simple problem, for it can be given a categorical answer; yet it is so hedged about with extraneous factors having apparent significance that our feebly discriminative brains often fail to accept the really pertinent evidence when it is set before us. It is, in fact, one of those subjects that can be made to seem mysterious, that can be wrapped in folk-lore and pseudoscience, and these are as popular with adult infants as other fairy stories are with the nursery variety. People do so love to be mystified. Logic and reason, when used at all, are last resorts. Recent evolutionary acquirements, they are kept, like new clothes, for state occasions.

A generation ago the situation was worse than it is to-day. Maternal impressions were the vogue—psychic influence raised to the *n*th power. Whole volumes were filled with records of remarkable ways in which the human organism reacted to mysterious and powerful forces—ancient folk-lore, a heritage of the witch-doctor era, perpetuated by their descendants, the quacks, charlatans, and ignoramuses who wrote the Family Medicine Books.

There was the same extraordinary monotony in these beliefs that there is in the plot of the modern short story. They were the result of repressed desires and of fear, and thus were in line with Freudian theory. A child with a small *nævus*, which a vivid imagination could torture into a vague resemblance to a strawberry, was believed to be

so marked because its mother had had an intense longing for strawberries at a time when they were not obtainable. Another child, afflicted with harelip, was thought to owe its condition to the fact that a rabbit had startled the mother two months before its birth. A third unfortunate, doomed to walk haltingly on a clubfoot, was assumed to have been so cursed because his mother had been frightened by a horse.

These fanciful tales were rather picturesque, and apart from the fact that there was no truth in them, were not seriously objectionable. Perhaps they sometimes served a useful purpose, since they could be employed by skilful wives to gain more sympathetic and liberal treatment from husbands alarmed at the possible consequences to their prospective progeny if requests were refused. And then there were the *a posteriori* advantages. A frightened negro woman nearly always gave birth to a child of paler hue.

Fortunately, as progress was made in embryology, the crudest of these beliefs were buried under heaps of ridicule. Even the most poorly trained physicians absorbed enough of the facts of human development to know that a woman in an advanced state of pregnancy could not be frightened sufficiently to induce a skeletal malformation in her unborn child when the skeleton of said child was already formed. Similar difficulties confronted the idea that the psychic state of the mother could influence the child, when investigations in neural anatomy showed that there is no physical connection between the nervous systems of mother and embryo. There are no nerves in the umbilical cord. In fact, the only communication between mother and foetus is through the blood-vessels; and this method of communication is limited to the interchange of gases and solutions through the thin walls of the capillaries in the placenta, since the mother's blood does not circulate through the blood-vessels of the unborn child.

There being a perpetual market for "gold bricks" under

one name or another, however, one finds that books are still sold in considerable numbers in which all the crimes and delinquencies of the human race are ascribed to wrong thinking on the part of prospective parents. Even expectant fathers do not escape. It takes an extraordinary imagination to conceive of the necessity of a course of pious meditation on the part of the average human male in order to enter upon fatherhood properly assured that his offspring will be desirable. Had this been the case, one suspects that the world would have gone to the dogs long ago.

These statements should lead no one to infer that hygienic measures may be dispensed with during pregnancy. Quite the contrary. But one must distinguish between the ordinary physical hazards of life and the fanciful witcheries which the maternal impressionists take for granted.

Early human development partakes somewhat of the parasitic, and the new generation tends to wax strong at the expense of the old. It is extraordinary how chubby and vigorous are the offspring of underfed women, a fact brought out very clearly during the World War. Undernourished women enduring great emotional stress gave birth to children who were practically as healthy as those born during times of peace.

Yet in spite of this masterful expedient of Nature, and in spite of the fact that the delicacy of our machinery made it necessary to evolve simultaneously a method of insulating the child from the mother rather effectually during gestation, the influence of the environment throughout this stage of life should not be underestimated. The unborn child is subject to casualties similar to those which may be experienced in after-life. If a pregnant woman falls downstairs her child may be killed outright or may be born with a malformed spine or limb. There is also statistical evidence to show that toxins generated in the blood of the mother may interfere with the proper development of the foetus. These poisons may be of the type produced by lead, phos-

phorus, mercury, or alcohol; of the type produced by infectious diseases, such as tuberculosis or syphilis; or of the type produced by any poorly functioning body mechanism, such as the intestinal tract or the nervous system. Even such common occurrences as overwork or too frequent child-bearing have their effects. Pinard, whose work in France was the starting-point for the extensive campaign of recent years against the all too common neglect of expectant mothers, has shown that the children of mothers who rest during the last three months of pregnancy are heavier and more robust than the children of mothers who have worked during this period. And R. J. Ewart¹ and others have offered figures substantiating the claims that children born at intervals of less than two years compare unfavourably in height, weight, and general vigour with those born at longer intervals.

Obviously there is nothing mysterious here. An accident may maim, a generally inhospitable environment may retard, development. But are not more serious consequences to be expected in certain cases? In some of the lower animals, for example, excessive alcohol poisoning sometimes leads to the production of monstrosities, as has been shown² by Pearl, by Stockard, and by MacDowell—to mention three of the most distinguished investigators. Development appears to be shifted to a new path by the effect of alcohol either upon the germ-cells or upon the very young embryo. Is it not likely that alcohol will produce similar effects when it has the opportunity to act on human beings? Alcohol is merely selected for consideration as one of the typical “tissue

¹ R. J. Ewart. “The Aristocracy of Infancy and the Conditions of Birth.” *Eug. Rev.*, 3: 142–170, 1911.

² Raymond Pearl. “The Experimental Modification of Germ-Cells.” *Jour. Exp. Zool.*, 22: 125–164, 165–186, 241–310, 1917. C. R. Stockard and G. N. Papanicolaou. “A Further Analysis of the Hereditary Transmission of Degeneracy and Deformity by the Descendants of Alcoholized Mammals.” *Amer. Nat.*, 50: 65–88, 144–177, 1916. Other papers are cited. E. C. MacDowell. “Alcoholism and the Growth of White Rats.” *Genetics*, 7: 427–445, 1922. Other papers are cited.

poisons." Lead or phosphorus would serve as well, were observations of their effects as plentiful.

When one examines the long series of contributions on this subject, he is at once struck with the obvious passionate prejudice of the authors. In the main, they are propagandist wets or dries who have come to their conclusions in advance of the facts, and are bent on proving their points of view. A generation ago Doctor W. O. Atwater, in his day the leading nutrition expert of the United States, proved irrefragably that dilute alcohol in moderate quantities, such as would be absorbed in beers and light wines, is completely digested. It is, in fact, a food, but a type of food to be used sparingly. Any one with a slight knowledge of chemistry might have predicted such a result, since alcoholic fermentation is a natural process, and small quantities of the product are found in such common foods as bread and prepared fruits and vegetables. For this piece of scientific investigation Atwater was literally hounded to death by the good ladies of the Women's Christian Temperance Union. The most recent intensive inquiry on the alcohol problem, and one of the finest ever carried out, is that of Raymond Pearl¹. The question set for answer in this work is whether moderate drinkers live as long as abstainers. They do. Only those who drink immoderately, the heavy drinkers, have their lives shortened by alcohol. I expect to hear the opening broadsides from the W. C. T. U. against Pearl at any moment. He will be harder to dispose of, for he is tougher-minded than Atwater.

Atwater, Pearl, and even the most reasonable of the avowed wets, agree that excessive use of alcohol affects the user adversely. I merely call attention to their work to show that the problem before us here has nothing to do with the social problem of legalising or prohibiting the sale of alcohol as a beverage. What we want to know is whether excessive use of alcohol by parents affects the bodies of the

¹ Raymond Pearl. *Alcohol and Longevity*. New York, Knopf, 1926.

children as well as their own, either by acting upon the parental germ-cells or upon the developing embryo.

A large number of investigations are now available, as indicated above, where lower animals have been repeatedly alcoholised to the verge of death and their progeny studied. Numerous abnormalities not found in control stock have appeared. The families are often smaller than with untreated parents of similar ancestry. These results indicate that alcohol has an affinity for the cells of the reproductive organs, as Nicloux and Renault concluded some years ago; and that it kills some germ-cells and maims others. Human beings, however, cannot be experimented with in the same way as the lower animals, nor do they imbibe alcohol in the quantities given in the animal experiments. One must decide then, from such statistics as can be gathered, whether immoderate use of alcohol, in the sense that that phrase is ordinarily used, has effects similar to those found in the animal investigations.

There are *a priori* reasons for believing that maimed germ-cells are less likely to function in human beings than they are in more primitively organised species. Our machinery is complex, and, because of its complexity, may be stopped more easily; but it is unlikely, for the same reason, to run wild. Nevertheless, we must take the facts as we find them, though we may utilise any pertinent knowledge in interpreting them. What are the facts?

Forel,¹ the leading psychiatrist of Switzerland and a rabid prohibitionist, believes that the vital statistics of his country show two maxima for the conception of idiots and other defectives—carnival time and the time of vintage, when, he says, people drink to excess most frequently. Some writers, taking Forel's statements as fact, have interpreted them as the results of periods of great license which give the defectives of the country greater opportunities for mating than

¹ August Forel. *Alkohol und Geistesstörung*. Lausanne, 1891. *Die sexuelle Frage*. München, Reinhardt, 1905. 13th ed., 1920.

at other times. But the real truth is that both the data and the reasoning of Forel leave much to be desired. In the first place, people do not drink much at vintage-time. They are too busy; and, anyway, the wine is too fresh to be enticing. In the second place, Forel fails to calculate his maxima properly with *due allowance for the maxima of total births*. When this is done, it is found that there is no significantly greater *proportion* of idiot births to total births at one time than another. Notwithstanding the fact that Forel's data fail to be convincing, there are data which show that among confirmed alcoholics of certain stocks a greater proportion of defectives are born than among total abstainers. In contrast, Tredgold¹ and others have shown that among good stocks, such as those of the Scotch fishing villages, procreation of defectives is not excessive during periods of drunkenness. What, then, shall we conclude? Simply that alcoholism is an effect of degeneracy, not a cause. Possibly there are exceptional cases where it is a cause, but the matter has not been proved. The usual thing is that stocks affected with neurotic taints, particularly feeble-mindedness, are more likely to be immoderate alcohol users. They would produce a high proportion of feeble-minded children, whether given to excessive use of alcohol or not, but being weakly inhibited through heredity, they are prone to be alcoholics. In this conclusion we are following findings of Karl Pearson, the great English statistician, who made a study of 4,000 children of alcoholic and non-alcoholic parents. Goddard, our own distinguished student of feeble-mindedness, concurs.

In these illustrations we see some of those jagged difficulties against which the overenthusiastic environmentalist bumps his head. He divides a group of people into two classes, one having had experiences which are somewhat different from the other. Noting then that certain characteristics of the two classes are more or less unlike, he ascribes

¹ A. F. Tredgold. *Mental Deficiency*. New York, Wood, 2d ed., 1915.

the difference to their variation in experience. More likely than not, his conclusion is wrong, for in a great proportion of such cases the hereditary differences which bring out the divergent characteristics also tend to throw the possessors into different types of experience. There is also a second fallacy in his reasoning. As was shown in Chapter IV, one environment may be such as to bring out full development of certain characters for which the individual has inherited the proper genes, while a second environment may tend to inhibit the development of these characters, though genetic constitution is the same in both cases. Such effects have been proved time and again on laboratory material. And since the mode of human inheritance is the same as that of the humble organisms used in the laboratory, it is not difficult to see that conflicting genealogical data must often be given the same interpretation.

If we had only these analogies, however, the case would not be so easily won by the geneticist. Studies of mutation frequency, the frequency with which characters genetically new appear, have given us more critical evidence on the subject.

Suppose one is growing a series of pedigreed cultures of genetic material in the laboratory or the garden. He notes the characteristics of each individual raised. Most of the characters observed appear frequently and can be so grouped that the method by which they are inherited is obvious, because they vary but little. One particular trait, however, exhibits unusual variability. Is the investigator dealing with the variability manifested by several inherited characteristics or with one genetic type showing hypersensitiveness to slight environmental differences which cannot be controlled? It is a fair question and can be answered by proper experimentation. The worker selects individuals that vary in appearance and purifies them genetically by inbreeding. These strains he grows under uniform and under non-uniform environments. The results show that environment is caus-

ing the trouble. The strains are alike genetically, but individuals vary somewhat in development as a direct effect of the different media in which they are grown.

A second trait appears that is new to the observer. Again he asks the question: Is it a new genetic character or a new manifestation of an old one, brought out by a peculiar combination of circumstances? Careful tests, made in the same manner as before, give him the answer. It is an hereditary character quite comparable with others with which he has been dealing. It is a peculiar combination of existing genes not to be expected frequently.

By essentially the same procedure, he proves that a third character is due to a new gene, a mutation. A novel reconstitution of genetic material has occurred. This he can prove concretely beyond a reasonable doubt.

Now tens of thousands of such experiments have been made, and the sum total of the evidence is that true mutations, the effects of genes really new to an organism, appear rather infrequently. A few genes are relatively unstable. Variegated patterns of flowers and fruit, for example, show changes as frequently as one per 200 individuals. But even these characters vary along definite lines, as from variegated to non-variegated and back again. Really novel character changes are much less common. Morgan and his coworkers have probably examined 10,000,000 of the little fruit-flies that have given us so much information on heredity, and have found only a very few thousand mutations. Hundreds of millions of plants and ears of Indian corn have been under observation by competent experimenters during the past quarter-century, and only two characters have been proved to be new mutations originating under controlled conditions. Naturally, this is what should be expected. Nature cannot afford to be too radical. This is why evolution is a slow process. This is why many of the ants of the Baltic amber, described by Wheeler, are just like the ants of to-day, though they are 3,000,000 years old.

Presumably the reader is wondering what these observations have to do with human affairs. I am coming to that. Experimental observations appear to show that the higher we go in the scale of evolution, the less frequently do new mutations appear. It is not necessary to suppose that this was always the case. Possibly millions of years ago the changes that gave us the group to which we belong, the mammals, took place relatively rapidly. But to-day mammals mutate exceedingly rarely. And man is a mammal, the most highly specialised mammal. No change whatever has occurred in any single human being since genetics has become a science, which can be proved to be a mutation new to the race. Mutations may have occurred, but, if so, they are identical with known characters, with mutations that have occurred before. It is simply unthinkable, therefore, that one should conclude that the appearance of every case of feeble-mindedness or other abnormality appearing in a stock developing under an undesirable environment is due to the conditions under which development took place. Obviously, human beings differ by an extraordinarily large number of hereditary traits. They are a non-uniform lot. But they have had a million or more years of racial history since the genus *Homo* was differentiated from its quadrupedal parent stock. During that time, billions of children have been born under every conceivable type of environment. Chances for variation have been numerous. How is it that the striking heritable abnormalities number only a couple of hundred or so, and that these abnormalities appear by the hundreds of thousands in every generation? The only satisfactory answer is that these deviant types are the result of germ-cell recombinations. They are the physical burdens carried along from generation to generation by the human race, no more to be wondered at than blue eyes or curly hair.

Yet if changes in human germ-plasm occur so rarely to-day that none can be detected with certainty, nevertheless

those changes which form the genetic basis for the variability that it presents must have occurred at some time. What has been the cause? No final answer to this question can be given at present. We know that the ordinary heredity mechanism sometimes jumps its well-worn track, and when it gets back again, the product is not the same. Various cases of this kind have been analysed with astonishing accuracy by the combined help of microscope and breeding-pen. There are also cases where our unit of heredity, the gene, appears to take on a new constitution. It becomes metamorphosed either physically or chemically, and the result is a mutation. By proper experiments it can be proved that the change must have taken place in one particular gene and no other. But as to why these changes occurred, nothing definite can be said. We attribute them to chance, though we know, of course, that the term "chance" is only a transnomination for a cause which we do not understand. And since any such physical cause must be a part of the environment, we must admit that the environment is the basis of the changes that have given us evolution.

Here we are, then. All biological discussions seem to lead to the ever-verdant topic, the inheritance of acquired characters. We have admitted that mutations are in some way caused by the environment, though we have steadfastly maintained that mutations are rare. I am perfectly certain, therefore, that many readers will be convinced that I have admitted the inheritance of acquirements. I have admitted nothing of the kind; but the protagonists on this question are prone to believe according to their desires. The will to believe sadly addles our logic, as Freud has shown in his interesting book, *The Mistakes of Everyday Life*.

Hitherto, experimental modification of the germ-plasm has been decidedly unsuccessful. It has been tried a great many times and in various ways. The earlier experiments were rather stupid. Bobbing the tails of rats and mice in successive generations was the favourite technique. Even

the great German zoölogist, Weismann, lent himself to this nonsense for several years. I never could understand why, for almost every part of the human body that could be mutilated without serious consequences has been so treated from time immemorial, as a social custom; and without effect. More recently, the investigators have shown greater astuteness. They have endeavoured to prove the inheritance of ability to learn, to show the persistence of modifications acquired under a new environment, *B*, when the possessors or their descendants were taken back to their customary environment *A*. Nothing positive has been proved. A great many of the experiments were performed by men not trained in genetic research, and were so spotted with genetic fallacies that they could not be crucial. Others savoured of the spiritualistic séance. One of these researchers, who had a great following among the uncritical, was exposed not long ago in the English publication *Nature*. He committed suicide. Still other experiments are as stupid in reality as the earlier ones. Their stupidity is merely a little more difficult to detect. Why, for example, should it be supposed that a modification acquired under a short experience in a novel environment, *B*, should, by its persistence in environment *A*, the environment to which the species was accustomed, show the inheritance of acquired characters? Characters acquired by long residence in environment *A* should be difficult to modify by a short experience in environment *B*; but if such modifications should occur, they should be transitory and should pop back with great speed to the original condition when the species is returned to its original habitat.

Several trained geneticists, however, are now working at this problem with great skill and ingenuity. They are guarding against genetic fallacies, and are using new methods of attack. Guyer is trying a serological technique. Little is using radium. So also are Blakeslee and Gager. Some of their results appear to be positive, though the investigators themselves are cautious in their interpretations,

and do not maintain as yet that they have modified the germ-plasm. But it is quite likely that they have. And even if they haven't succeeded up to this point, we may be certain that shortly some one will find the means to do the trick, using the newer discoveries of chemistry and physics to aid them. When this time comes, if it has not come already, the world ought to applaud as it should on the occasion of any advance of knowledge. But from the standpoint of genetics and human affairs, we will still be entitled to say. "*What of it?* We admit the probability now."

Proof that the germ-plasm can be modified experimentally should not lead any one to suppose that the problem of the inheritance of acquired characters as framed by biologists has been decided in the affirmative. The latter is a wholly different proposition. One may admit that the sum total both of the physical characteristics and of the behaviour of all organisms is due, in last analysis, to environment, and yet deny that inheritance of acquired characters in the classical sense has ever occurred. The distinction between the two propositions is simple. That which is admitted to be probable is the production of heritable variations by the physical factors of our universe. The technical biological problem is whether the adaptations to conditions exhibited in various degrees by all organisms impress the germ-cells in such a manner as to make evolution proceed in the direction of these adaptations.

In its sociological form the question is whether a heritage of hygienic experiences will assure more inherent vigour in future generations, whether algebra in the public school will increase their brain power, whether ethical teachings will give them less savage instincts. Many evolutionists insist that this must be so because of the path which evolution has taken; others hold just as determinedly that no such assumption is necessary and that experience is against it. Possibly both are correct. Inheritance of acquired char-

acters may have been a factor in that long course of change which has required so many millions of years, but if so, the effects are too slow or too infrequent for us to measure them in the infinitesimal period of time allotted to us for experimental purposes. We must solve our sociological problems, therefore, in keeping with the verdict that acquired characters are not inherited. Those who hope to get bluebirds from cuckoo's eggs hatched in a bluebird's nest are doomed to disappointment. A sharp chemist gained considerable publicity not long ago by advertising a silk purse made out of a sow's ear, but it turned out to be near-silk, after all.

Social evangelists always appear saddened at this decision on the part of biologists. Some go further, and become irritated, testy, choleric. These are the fundamentally timid souls, who, deep in their inmost cerebral cells, believe themselves to be vicegerents of God by special appointment, and who can brook no curtailment in the creative power of their endeavours, who simply must see racial progress promoted by the success of their particular benevolent society. For them there is no help; but I can see no reason why the sincere and sensible social worker need be discouraged. He can go on with his efforts to make the world a little better habitat, just as he did before. Surely the incentives which have led him to strive to improve the education, promote the health, and add to the social value of his people have not disappeared. We may regret, as Leonard Darwin¹ remarks, that efforts to educate the young cannot be relied on as a method of making the race inherently more teachable; but, on the other hand, we must rejoice that the terrible experiences of mankind in its upward struggle have not left ineradicable marks. Think of the mad horrors encountered daily, from the Stone Age to the Twentieth Century. Think of the hell the poor serfs of "enlightened" Europe endured 300 years ago—yes, 100 years ago. What would the ordinary man of to-day be if fettered by the experiences

¹ Leonard Darwin. *Eugenic Reform*. New York, Appleton, 1926.

of his ancestors? No, I am inclined to think that the existing situation is the one to be chosen.

"If it were true," says Major Darwin, "that the education of the young of to-day would materially increase the learning power of their children or grandchildren, then it would be right to push the education of this generation far beyond the point where it would be immediately advantageous. If it were true that an environment could be found that would increase markedly the likelihood of feeble-minded persons producing normal progeny, then it would be unnecessary to disturb ourselves over the ethics of the question whether or not they should be allowed to become parents. If it were true that motherhood endowments and doles would result in a radical and rapid improvement of the race, then their pauperising effects might be neglected." But this is not the philosophy upon which the current schemes of social reform are based. The most ardent Lamarckians assume that measurable inherited effects can be attained in such cases only by several centuries of continued effort. In only a few instances, therefore, is it necessary to modify our view of a social problem because of the feeling among biologists that any possible inheritance of acquired characters can be exhibited only in those long periods of time that mark our geological eras. Of these, immigration is probably the most important. Several centuries of training, paid for from the engorged treasury of a rich country, might not be too great a price for the self-satisfaction of its inhabitants in alleviating the conditions of a group of socially and financially submerged aliens, if it could be guaranteed that their germ-plasm would be good germ-plasm in the end; if the charitable country is reducing its biological batting average in the meantime, the proposal takes on quite a different status.

Having torn away some of the verbiage surrounding the question at issue, let us endeavour to answer it. The question, we must remember, is not whether either environment

or heredity is the more important. One does not ask which gives us a plant, the seed or the soil. Both are indispensable. They are collaborators in creative work. We merely ask what function each performs. The answer which biology gives, an answer based upon concrete evidence, is definite. Heredity is the exposed film, environment is the developer; heredity is the raw metal, environment is the craftsman; heredity is the score, environment is the performer. Better still, heredity is the credit at Nature's bank, deposited for the individual at conception. One has ten talents; a second, five talents; and a third, one talent. What they do with their endowments depends upon circumstances.

Examine a series of fertilised vertebrate eggs under a microscope. They all seem to be alike. During the first part of their development they still appear to be alike. Yet gradually differences appear. And in the end, we see a mullet, a frog, an eagle, a chimpanzee, a man. Does environment produce these differences? We know that it does not. Each egg starts with different materials and a different organisation of these materials. Compare the developing chimpanzee with the developing man. The embryos remain so nearly alike that even three months before birth only an expert can tell them apart. But how different is the end result! Is this due to the dissimilar conditions under which the embryos develop? No, this is not the answer, for we can develop the eggs of starfish and of sea-urchins in the same pan of sea-water, and they still produce their kind. They are different from the beginning. Has, then, the negro child the same potentialities as the white child? Have the Italian baby and the English baby no in-born variations? Are the two sons of Mr. and Mrs. John Doe alike? Why is it that so many people who are neither ignorant nor stupid will admit inherent differences in the more obvious of these illustrations, and yet, in defiance of all logic, will claim that all men were born equal? How do they think that evolution came about? Do they suppose

that the eagle arose suddenly in a family of crows? To the biological student the claims of the environmentalists reduce to just such an absurdity. They follow the facts of genetics until they reach mankind, or perhaps until they reach their own race, and then they become as illogical as a group of politicians.

Now, having made these few statements, I must make more, else I may convey the idea that environment has relatively little influence in developing the individual. The Behaviourists, led by that valiant knight, Doctor John B. Watson, state that 90 per cent of a man's behaviour is due to his environment. This may be true, though there is no way of proving it. All the geneticist objects to is the implication in the statement. Whether or not the followers of this School intend to lend their authority to such a doctrine or not, laymen obtain the idea that man is a sort of mixture compounded of 90 per cent environment and 10 per cent heredity. A bad heredity, therefore, can be overwhelmed by a good environment. Such a conclusion is absurd. Without being illogical, one might assume that every reaction is due to a stimulus from the environment, and yet maintain that every variation in reaction exhibited by different individuals to a given environment is due to heredity. The two things are fundamentally distinct.

If we get back to the elementary principles of pure genetics, we may be able to see a little more clearly through the mazes of this perennial debate. First, one must remember that an individual inherits no characters whatever. A man may say that he inherited his blue eyes, but the expression is just a convention, like many other common phrases. His heritage was a series of packets of genes, which went through complex chemical interactions until finally an adult creature emerged that really did have characters by which it could be described. The geneticist takes two sets of gene-packets differing from each other by one pair of genes only, and allows them to fuse and to develop under the most constant

environment he can give them. This he has done thousands of times, for fertilised eggs are nothing but gene-packets. By observing what occurs when this is done, he has determined the way in which *gene differences* are inherited. Yet he has called this process the mode by which *characters* are inherited.

How much error is propagated by this conventional way of speaking? Very little. If there is one thing more outstanding than another in the genetic research of the past few years, it is that the variation that can be induced to develop in a fertilised egg of given genetic constitution by dissimilar environments is very small. Perhaps this is because the extremes of temperature, moisture, food, etc., within which development can take place, are unimportant; but, at any rate, the fact remains.

If we take a series of horticultural varieties—grapes, apples, peaches, plums, cherries, or what not, and grow them under the most varied environments possible, we can test the point, for every individual of each variety has the same genetic constitution, due to the asexual method by which it reproduces. What we find is that we can influence little but vigour. Development proceeds ill or it proceeds well, but a Damson plum is a Damson plum, and a Bartlett pear is a Bartlett pear wherever and however grown.

Or we can take a group of organisms in which reproduction is sexual, and, by continued inbreeding, can reduce the strain to a state where the genetic constitution of each individual is virtually the same as that of every other individual. Here again we find that variation under the most extraordinarily diverse conditions is confined almost wholly to variation in vigour—a fluctuating food-supply accelerating or retarding development. Furthermore, selection has no discernible effect in such a population. The progeny of large individuals average the same and show the same variability as the progeny of small individuals.

Summing up all the genetic experiments where the inheri-

tance was constant and the environment variable, it would hardly be an exaggeration to say that the resulting dissimilarity of product is negligible. Yet I do not wish to leave this impression with the reader. In some of the lower animals, development will take place in such an abnormal medium that the whole process is distorted. Stockard, for example, has produced fish with a single median eye instead of two lateral eyes, by adding chemicals to the water. And if, as Jennings remarked, these fish were always to live under the new conditions, they would probably continue to "inherit" the single median eye. Morgan has discovered a stock of fruit-flies which develop supernumerary legs at the lowest limit of temperature in which they can exist. But, after all, what do these examples show? Possibly all fish have the potentiality of either median eyes or lateral eyes, depending on the media in which they develop. No yet discovered treatment, however, can force the ordinary fruit-fly to develop supernumerary legs. It does not have the proper packet of genes. The potentiality, so far as we know, is characteristic of only one variety. Similarly, the heredity of the fish limits what it may do in the matter of eye production. When Stockard or Jennings finds out how to make a fish develop the compound eye characteristic of insects, it will be time to recast accounts; and that will be the same delightful period when the lion and the lamb lie down together. During premillennial times the course of development that an individual can take will be pretty narrowly delimited by its heritage, for the amplitude of variation permitted by environment will remain small.

Notwithstanding this general situation, genetics offers a straw to the grasp of the sinking environmentalists. Those unfortunates whose heritage is deficient reveal their deficiency by what they become under ordinary conditions of environment. When we say that children inherit feeble-mindedness or clubfoot, we mean that the genetic constitutions they have inherited are such that these defects appear

in the ordinary course of their development. And experience shows that the most diverse environments they are likely to encounter during development will have very little effect in changing the end product. In any ordinary course of events, the possessors of these particular genetic constitutions will have defective minds and abnormal feet. But it is possible that in the future we may be able to correct some of these defects. To-day we can correct short-sightedness by spectacles, we can correct defective bones by surgery, we can give an artificial immunity to certain diseases by serums; to-morrow we may be able to rectify some of the innate deficiencies which ordinarily would bring about an abnormal development.

There are numerous secretions essential to normal growth. The thyroid, the sex glands, the pituitary, the suprarenals, must function properly or serious defects in development occur. Cases are known where heredity is the basis of defect in each of these organs. They do not function as they should, through lack of the proper packets of genes. They do not produce the chemicals that are necessary if the child is to become a healthy, vigorous man or woman. Is it over-optimistic to assume that the chemist will find out how to make these essential products? I do not believe it is. Insulin is their forerunner. And when they are produced, a lot of individuals who now develop abnormally will have different prospects of existence.

One should not build too highly on these hopes, however. There will be progress along these lines. Of that there is no doubt. But it is likely that effective treatment will be found only for a few of the more striking cases where deficiency in a single gene exists, such as that which brings about the condition known as Mongolian idiocy. It is not likely that the dullard can be turned into a genius by medical treatment or by social advantages. The number of genes required to produce a mind is probably enormous. Each may vary in some degree. Those who obtain a set of genes making for capac-

ity will be brilliant, those who do not will be stupid. And so it will go until the end of Time.

And even if this heyday of advancement arrives, all will not be well, for the camouflaged defective will still produce defective germ-cells. We will have made it easy for tainted germ-plasm to survive. Will this be progress? Will this be race betterment?

I leave these questions for future generations to answer. To-day we have the lame, the halt, and the blind, the feeble and the vigorous, the defective and the normal, the fool and the genius, who are thus characterised because their particular hereditary endowments, under the environment ordinarily encountered, will allow them to develop in no other way. And, generally speaking, this will always be so. Three thousand years hence, as at present, we shall find that three boys of a given family, to say nothing of a given race, with similar care and similar instruction, will present to the world examples of dullness, mediocrity, and brilliance. The first may be the town loafer, the second the city banker, the third the nation's greatest philosopher. And they will show these differences because of their heredity, because of the dissimilarities in the packets of genes entering into their make-up. They will exhibit these differences for the same reasons that one will be a myopic blue-eye and another a far-sighted brown-eye. Environment will cause their development, experience will be the exciting stimulus for their reactions; but their differences will be due, preponderantly, to what came to them from their ancestors.

Telepathically I hear mutterings of criticism against this attitude. We grant you, the voices say, that heredity is highly effective in the final differences between individuals numbered among the lower organisms, the physical distinctions of rabbits, guinea-pigs, and fruit-flies; but man is different. He reacts more strongly to environmental dissimilarities. Possibly even his physical characteristics are determined largely by inheritance, but his mental attributes are dependent on his training.

I might point out that man is not unique in having mentality, that he merely has a more highly developed central nervous system than his various mammalian cousins, and that the reactions of this central nervous system by which we gauge mentality can hardly be divorced from the organs themselves as morphological entities. And since the mechanism of heredity has been proved to be the same for the physical attributes of man as for the lower animals, it follows that his innate mental differences are distributed by the same means. I might show how great these innate mental differences are, and then proceed to prove that these differences, either when measured by accomplishment or by psychological tests, with due allowance for differences in opportunity, are distributed just as they ought to be distributed if they are inherited like physical differences. But, as a matter of fact, indirect conclusions are unnecessary. Direct proof of our contentions is afforded by observations on identical twins. We shall make our final appeal, therefore, to this type of evidence.

Twins have long been objects of general interest, partly, as Newman¹ remarks, because of the fine humour of the situation, and partly because of the existence of so many cases of twins who can hardly be distinguished from each other. Biological inquiry has given them a special interest. There are two distinct types, fraternal and duplicate. Fraternal twins may be either of the same sex or of different sexes. They are no more alike than is usual among children of the same family. Nor should they be expected to resemble each other more closely than they do their non-twin brothers and sisters, unless believers in an all-powerful environment wish to stress their similar prenatal experience, for they are derived from two fertilised eggs. Duplicate or identical twins are always of the same sex, resemble each other very closely, and are derived from a single fertilised egg. The brother and sister twins who cannot be distinguished, and for this reason have furnished the basis of so many unexpected dé-

¹ H. H. Newman. *The Biology of Twins*. Chicago University Press, 1917.

nouements in drama and romance, are, in truth, fictions. They do not exist. Newman good-humoredly calls them "literary twins."

Duplicate twins are the type which interests us here, for the reason, of course, that if they come from a single fertilised egg, their inheritance is identical. Each has the same packets of genes with which the environment must work in its task of producing the finished individual. They are, in fact, the only real twins, as twinning is twaining.

For many years it has been suspected that fraternal twins arose from separate eggs and duplicate twins from a single egg. The evidence was indirect, but nevertheless was rather conclusive. There was first the fact that some twins, always of the same sex, are born within a single set of foetal membranes, while others have separate sets for each child. Second, records of nearly a million twin births show a ratio of approximately 1 male-male : 1 male-female : 1 female-female; whereas if all twins were of the fraternal type, the ratio expected would be 1 male-male : 2 male-female : 1 female-female. With good reason, therefore, one-half of the instances of like-sex twins may be assumed to be cases of duplicates. To-day there is a wealth of other evidence, genetic, embryological, statistical, and psychological. The reader will find it recorded, in brief, in two engrossing books by Newman.¹

Francis Galton² (1883) was the first to undertake a study of the physical and mental resemblance of twins, a pioneer in this, as he was so often in scientific work. His results are hardly susceptible of quantitative record, but they make interesting reading. The twin histories he obtained were of two types. Some twins were unlike or showed only an ordinary degree of resemblance, others were practically identical, both in physical appearance and in mental reaction. The identical twins were always of the same sex, and in many

¹ L. c.

² Francis Galton. "Inquiries into Human Faculty and Its Development." Reprinted in *Everyman's Library*.

of his cases the resemblance was so great the author had recourse to the study of palm and foot prints. This last investigation he did not complete in any great detail; but Wilder,¹ who studied the subject carefully a number of years later, found that the ridges of the feet and hands of duplicate twins were not only more nearly alike than is ever the case among ordinary brothers and sisters, but sometimes the ridges of one twin were mirror images of those of the other.²

Galton says: "Making reasonable allowance for unintentional exaggeration, the impression that all this evidence leaves on the mind is one of some wonder whether nurture can do anything at all, beyond giving instruction and professional training." And again: "There is no escape from the conclusion that nature prevails enormously over nurture when the differences of nurture do not exceed what is commonly to be found among persons of the same rank of society and in the same country."

More recently Merriman³ (1924) made a study of Intelligence Tests of a considerable group of like-sex and unlike-sex twins. The average coefficients of correlation, which are coefficients of association and, therefore, of resemblance, were .838 for like-sex twins and .592 for unlike-sex twins. Since half of the like-sex twins are presumably fraternal twins, which reduces the difference between the two coefficients, the mental similarity of the duplicate twins is very pronounced.

An extended study of the same type by Lauterbach⁴ (1925) yielded similar results. This author comes to the following

¹ H. H. Wilder. "Palm and Sole Studies." *Biol. Bull.*, 30: 135-172, 211-252, 1916. See also "Duplicate Twins and Double Monsters." *Amer. Jour. Anat.*, 3: 387-482, 1904.

² There is considerable evidence that both types of twinning are to some extent hereditary. Presumably fraternal twinning cannot be influenced directly by the father. One-egg twinning, however, appears about as frequently in the family tree of the father as it does in the ancestry of the mother.

³ Curtis Merriman. "The Intellectual Resemblance of Twins." *Psychological Monographs*, 33, *Psychological Review*, Princeton, 1924.

⁴ C. E. Lauterbach. "Studies in Twin Resemblance." *Genetics*, 10: 525-568, 1925.

conclusion: "The fact is well attested by the evidence that like-sex pairs of twins show a greater degree of intellectual resemblance than unlike-sex pairs of twins, and it is probable that these differences exist by virtue of original nature, since environments which seem to be similar have little influence in modifying the relationships."

I was talking over these and similar data with a distinguished sociologist with environmentalist yearnings. He was unregenerate. He thought he was unbiassed, but he really was like the Scotchman who said: "I am willing to be convinced, but I suld like to see the man as could convince me." His reply was that one could not tell what differences in environment were significant and what were not, though just how this fact negates the data of Lauterbach and of Merriman I am still unable to see. For such as he there are more critical cases in the literature, cases where duplicate twins have been separated shortly after birth and brought up under very different circumstances. The case that has been studied in greatest detail is one reported by Muller.¹ If the environmentalist cannot be persuaded to accept this evidence for nature as against nurture, then he is a hard case, and I give him up.

These twin girls, B. and J., were born March 24, 1893, of American parents, in a South Dakota mining-camp. They remained with their mother, who did not nurse them, only two weeks. After this they were separated permanently, with the exception of one additional week in early infancy, and did not see or communicate with each other until 18 years of age. B. was brought up by foster-parents engaged in mining and hauling. As a child she was usually out-of-doors with the teams and had only four years of formal schooling, including nine months at a business school. At 15 she engaged in clerical work, and since has had an active business career in various places, including France,

¹ H. J. Muller. "Mental Traits and Heredity." *Jour. of Heredity*, 16: 433-449, 1925.

during and after the war. The foster-parents of J. were fairly well situated financially, owning a ranch and road-house, and sent the girl through the grades and high school, the high-school course being finished in three years. Later she had some summer university courses. J. has remained in the West, her career being that of a school-teacher. She married in 1915, when she was 22 years of age, and has one child, a boy.

B. was less vigorous than J. as a baby, but this was probably due in large part to improper food and to large doses of laudanum. In childhood B. was subject to a disorder of the stomach. She also contracted measles, mumps, chicken-pox, and typhoid. J. had no special stomach disorder, but contracted whooping-cough, measles, mumps, and scarlatina. Both suffered from backache, due to congenital shortness of the tendon of Achilles; both contracted tuberculosis when about 18 (J. also having pneumonia), and both came near to a severe nervous breakdown a little later. Their physical peculiarities are practically identical.

Mentally both were active, talking at eight months, learning to read at six or seven, and reading a great deal in after-life. They were out-of-door children, imaginative, somewhat tempestuous, but on the whole normally good-natured. B. obtained her education by her own forcefulness, J. obtained hers rather by accepting what was offered. They are interested in religion, but their intellect, rather than their emotions, rules. They are both normally gregarious, and though B. has never married, she has had plenty of attention from the male sex.

Here, then, are duplicate twins, as Muller demonstrates mathematically, fed, housed, and educated in wholly different manners, who are yet so similar that they are mistaken for each other, who have developed mentally in a similar manner, who have experienced almost identical physical ills, and who show a strong community of interests.

Given the Army Alpha intelligence test and the Otis ad-

vanced intelligence test, they scored 156 and 153 respectively in the former, and 64 and 62 in the latter. These scores are so high that unless these tests have genetic significance, the chances are over 300 to 1 against there being such a coincidence in scores. Furthermore, it should be noted that the slightly higher ratings, though they are not statistically significant, were made by B., whose opportunities were less ample than those of J.

CHAPTER VIII

MARRIAGE BETWEEN NEAR KIN

AMONG the legal links of our involved judicial network are laws against the marriage of blood relatives. About one-third of the States prohibit marriages between first cousins; North Carolina, Oklahoma, and South Dakota forbid unions between first cousins once removed; and nearly all of the States frown upon a closer relationship, though in Pennsylvania a man has the somewhat embarrassing privilege of marrying his grandmother.¹

These restrictions are commonly supposed to be justified by an instinctive, and therefore universal, repugnance towards consanguineous unions. Some of the credulous who dwell among us even maintain that the more scrupulous of our four-footed acquaintances regard such customs with aversion. If it is pointed out that the facts of natural history and psychology do not support these claims, that in-and-in breeding is a very ordinary farm practice, and that, by analysing the vagaries of the subconscious mind, our own feelings on the subject can be shown to be acquired, the retort comes that, at any rate, such laws are biologically sound, since consanguineous marriages produce defective offspring.

There is some truth in the last observation. It cannot be denied that the issue of a consanguineous marriage is sometimes defective. But evil results do not invariably follow. Numerous cases are known where such offspring are remarkably healthy and vigorous. Why, one naturally asks, are the effects of inbreeding so irregular if the practice

¹ C. B. Davenport. "State Laws Limiting Marriage Selection Examined in the Light of Eugenics." *Eugenics Record Office Bull.*, 9, 1913.

is in and of itself deleterious? Why also, if these laws were enacted to prevent the undesirable results which follow too close a mating, do they sometimes include restrictions against marrying relatives of a deceased consort, where no blood relationship whatever is involved?

It is not easy to frame categorical answers to these questions. In general, our marriage laws are not unreasonable. They are similar to those found in other parts of the civilised world, and have at least a stone or two of scientific foundation. But they were not enacted on a basis of previously ascertained fact, neither they nor their prototypes. That is not the way legal minds work. On the contrary, like other parts of our social framework, they are founded upon ancient customs whose origins are lost in the misty beginnings of Time. Westermarck¹ has written a *History of Human Marriage* running to some 1800 pages, and that indefatigable collector of traditions, Sir J. G. Frazer,² author of the *Golden Bough*, has compiled four fat volumes on the one phase *Totemism and Exogamy*, but neither has been able to give even a moderately rational interpretation of human mating habits.

Propaganda in behalf of strict marriage rules was apparently very prevalent among the substantial paleoanthropic citizens who stood for law and order. Tribes in all parts of the world developed and steadfastly maintained their own codes, presumably without much reference to the customs of their neighbours; yet a tally of the usages thus evolved shows that they divide naturally into two grand divisions. One set forbade the members of a particular clan to marry outside of the group, the other prohibited marriage within the group. The rules, therefore, belonged to the "thou shalt not" category. No society, according to Westermarck, made a particular choice compulsory on its members, but

¹ Edward Westermarck. *The History of Human Marriage*. Ed. V, 3 vols. New York, Allerton Book Co., 1922.

² J. G. Frazer. *Totemism and Exogamy*. 4 vols. London, Macmillan, 1910.

everywhere there has been either a forbidden outer circle or a forbidden inner circle, within the limits of which marriage was considered improper. Two distinct folkways thus came into being, though the systems were not mutually exclusive, since endogamous tribes often prohibited marriage between certain classes of relatives, and exogamous tribes often objected to alliances with peoples who were decidedly alien in feature and custom.

Endogamous practices are commonly assumed to have grown out of racial or family pride, with actual antipathy to foreign peoples and unfamiliar habits playing a minor rôle; opinions concerning the origin of exogamy have been less harmonious. Theories are legion, and they have been debated with more asperity than logic for many years.

It is said that relationship might become too involved if marriage took place between near relatives, that wealth would be overconcentrated, that modesty would be outraged, or, more simply, that God has forbidden it.

McLennan,¹ who coined the word exogamy, naïvely explained it by the prevalence of female infanticide everywhere, and the consequent necessity of marriage by capture. He failed to realise that infanticide was here merely a primitive means of relieving overpopulation in which the girls were by no means always singled out for destruction. They were too useful. Somebody had to do the work. Furthermore, marriage by capture was never the normal way of obtaining a spouse. If it had been, a tribe would have been hard put to it for survival over any great period of time. Spencer's theory² was somewhat similar. He assumed that exogamy became the accepted practice among habitually victorious tribes and endogamy among those which were constantly worsted. The captured wives were trophies of

¹ J. F. McLennan. "The Levirate and Polyandry." *Fort. Rev.*, 22, 1877. *Studies in Ancient History*. 2d ser. *An Inquiry into the Origin of Exogamy*. Ed. by Mrs. McLennan and A. Platt. London, 1896.

² Herbert Spencer. *Principles of Sociology*. 3 vols. London, 1882-96.

valour. Lord Avebury¹ also derived exogamy from marriage by capture, but he based its development on the theory of communal marriage within the tribe. The women taken in war were assumed, against much evidence to the contrary, to be personal property.

The biological theory, ascribing evil results to inbreeding, has been a favourite. Sir Henry Maine² thought it quite within the limits of probability for the same brainy savages who discovered fire, tamed wild animals, and selected desirable vegetables for cultivation, to have found that nearly related parents produced weak children. And it is certainly true that many people feared the results of such marriages. Even the primitive Dieyerries³ of Australia had a tradition that after the creation the closest of kin married promiscuously, and that evil results followed the practice. Whereupon a council of chiefs petitioned Muramura, the Good Spirit, to find out what should be done. In answer, Muramura "ordered the tribe to be divided into branches and distinguished from each other by different names, after objects animate and inanimate, such as dogs, mice, emu, rain, and so forth, and forbade the members of each branch to marry other members of the same branch." Similar beliefs are common in many countries, as witnessed by legend and proverb. But which is horse and which is cart? Did exogamy arise because the consequences of endogamy were justly feared, or were terror tales invented, as they are to-day, to keep the radical souls in line with custom? Biologists worked out the genetics of inbreeding just 15 years ago. Did they merely rediscover what every barbarian tribe knew long before the dawn of history?

The remaining hypotheses, though held by some of the most distinguished living ethnologists, seem to me to be

¹ Lord Avebury, Sir John Lubbock. *Marriage, Totemism, and Religion*. London, 1911.

² Sir H. S. Maine. *Early Law and Custom*. London, 1883.

³ Cf. Westermarck, *l. c.*

just as childlike and bland. Morgan¹ and, following him, Sir James Frazer believe that exogamic customs were installed to prevent incestuous marriages, particularly those of brother and sister. In other words, the system was evolved in order to prevent at least some of the things it did prevent. But why? On this point Sir James is silent except for the suggestion, rather hesitatingly put forward, that such marriages may have been thought to be injurious to the community rather than to the progeny. "Against public policy," we would say. Westermarck and Havelock Ellis,² on the other hand, see in exogamy only a legal expression of the amatory indifference supposed to exist among members brought up in the same household. It is hardly dignified to dispose of this interpretation by the question: "Do men go to great lengths to forbid what will not happen anyway?" Yet the flippancy of the query hardly overmatches the silliness of the theory.

These tortuous ways of explaining exogamy have little value. We are still in the dark on the whole matter. If any suggestion is worth considering, it is that of Freud.³ However exaggerated some of Freud's psychology may be, his analysis of totemism strikes one as having possibilities.

What concerns us here is that exogamic tribes were usually totemic, and that marriage between members of the same totem was nearly always proscribed by totemic law. As the totem was hereditary, and maternal inheritance was the rule in the more primitive tribes, if a man of the Snake totem married a woman of the Crane totem, the children were Cranes. This system, therefore, made it impossible for a man to marry any of the women of his own group and went far towards preventing unions with blood relations. Nevertheless, it is clear that it was not a true genetic exog-

¹ L. H. Morgan. "Systems of Consanguinity and Affinity of the Human Family." *Smithsonian Con.*, vol. 17, 1871.

² Havelock Ellis. *Sexual Selection in Man*. Philadelphia, 1906.

³ Sigmund Freud. *Totem und Tabu*. Leipzig, 1913.

amy, since it permitted marriage with near relatives who were of different totems and forbade marriage between those who were not related if they had the same totem.

Superficially considered, these facts would seem merely to show that the savage had an unusually strong incest dread; but, as Freud points out, the marriage prohibitions of totemism are only special cases of taboo. The taboo was highly developed and differentiated; it was the whole jurisprudence. It protected the important ones of the tribe from profanation and the weak ones from attack, it safeguarded the clansmen against the wrath of the gods, it preserved them from the dangers incurred in coming in contact with death, it assured safety in the important crises of life. *How* the master-minds of the day put the system through and inculcated the proper terror of taboo violation is something of which we are wholly ignorant; but the Freudian theory of ambivalent emotions makes it quite clear *why* it was evolved, for many of the early prohibitions were more sensible than those we have retained to-day.

When for any reason it became public policy to prevent certain acts to which the people naturally might be inclined, these acts were identified with the totem and became sacred. The wish to do the acts might remain undiminished; but the counter-wish, enforced by the very real dread of taboo violation—which presumably had its origin in pains and penalties experienced after engaging in certain proscribed undertakings and had been enhanced by priestly propaganda—was usually master of the situation. Marriage prohibitions were probably secondary developments of totemism. They were instituted simply because it became social policy to prevent certain unions which propinquity and inclination made overlikely to occur. Undoubtedly the chieftains and priests had reasons for their edicts. What they were we do not know. Judged by our own reactions in similar circumstances, they are likely to have been emotional rather than rational.

The chief civilisations influencing our own marriage laws were those of the Hebrews and the Romans, but these in turn were guided to some extent by the practices of the Egyptians and the other Semitic nations on the one hand, and by the Persians and the Greeks on the other.

The Egyptian Pharaohs and Ptolemies were accustomed to marry their sisters, as also were the rulers of the ancient Peruvians, in order not to debase their line with ignoble blood; but there is no good evidence that the Egyptian commoner followed the same practice. Galton¹ felt that the Ptolemaic experience led to sterility. Huth² denies this, and cites statistics to show that brother-sister matings produced just as many children as alien unions. Ptolemy, the historian, states that the early Semites followed the same practice, but later evidence places the matter in doubt.

Zoroaster appears not only to have permitted cousin marriages but to have recommended and blessed them above all others, though Westermarck doubts whether the custom was general. The Mohammedan prohibitions were much the same as our own. The Greeks, on the other hand, as would be likely in a small, proud, and highly civilised nation surrounded by barbarians, were essentially endogamous. We have no statistical evidence concerning the degree of inbreeding commonly practised, but Grote ascribes the fall of Sparta to a diminished population resulting from habits of intermarriage. This conclusion must have been merely a preconceived notion of what ought to happen, however, for during the period in which inbreeding was closest the Spartans were the greatest race physically of which we have any record. The fall came after the original customs had been relaxed.

The Hebrews, who, because of their religious legacy, have

¹ Francis Galton. "On Blood Relationship." *Proc. Roy. Soc.*, 20: 394-402, 1871.

² A. H. Huth. *The Marriage of Near Kin*. Ed. 2. London, Longmans, 1887.

influenced our marriage code more than any other race, were accustomed, before the time of Moses, to marry relatives by preference. Abraham, for example, wedded his half-sister, and Isaac sent Jacob to marry his first cousins Rachel and Leah. The mother of Moses was his father's paternal aunt, though he prohibited similar unions when he codified and defined the law. In this law it was forbidden to marry within the common degrees familiar to us to-day, with the one exception that unions of uncle and niece were not prohibited. Additional proscriptions were marriage with an aunt by marriage on the paternal side, or with a deceased brother's wife unless she came within the provisions of the levirate code, in which case marriage was actually enjoined.

Jewish men were also forbidden to marry foreign wives, except women taken in battle. But since the ban against alien unions did not extend to the women, and since there were various ways by which the men could avoid it, the result is that the race, contrary to popular belief, has become extremely variable.

Little is known of the marriage customs of the ancient Germanic races, though one may judge from tradition that marriage between near relatives was not uncommon. The Romans, like other vain races with higher civilisations than their neighbours, were averse to alliances with foreigners. Not until the *Lex Julia et Papia Poppæa* were such marriages permitted. As to marriages between blood relatives, "the elder the times were, the more liberty there was," according to Jeremy Taylor. But neither the customs of the Germanic tribes nor of the Romans as a people had much influence on the Christian world. Our sources are, first, the Hebrews and, second, the canons of the Catholic Church.

Generally speaking, the canons of the church have tended to make marriages between relatives more and more difficult, but its rules have not been inflexible. Saint Augustine taught that marriages of first cousins were opposed neither to the law of God nor of man, yet before his death they were

prohibited under pain of death. A little later the penalties for such marriages were mitigated but the prohibitions were extended. In the church councils of the sixth century, marriages in the sixth degree were proscribed, an extraordinary provision, since canonical law counts degrees of kindred backward to the common ancestor over the *longest* line. The prevailing law to-day was established in the twelfth century, and permits marriages beyond the fourth degree (third cousins). Another odd decision of the early church, confirmed by the Council of Trent, was to the effect that a person baptised, his godparents, and the priest who baptised him were as much related as though they were blood kin. "Accordingly," says Huth, "no tolerably near relative of the priest could marry the god-relatives or relations of any child that the priest might have baptised." No wonder Beatrix exclaimed: "Adam's sons are my brethren, and truly I hold it a sin to match in my kindred!"

Though the Protestant churches have been less severe in their rules on this matter than the Catholic Church, and though civil law has followed the more liberal interpretations, nevertheless the present-day Christian world—and for that matter, the world of the Mohammedans, Buddhists, and Hindus, also—is obviously exogamic. The rules in force are a part of current religious dogma; and since some of them cannot possibly have a biological justification, it is only reasonable to suppose that the wide-spread belief in the evil results following inbreeding is of secondary origin. The conviction may, nevertheless, be sound. This is our problem.

The question is fundamental to animal and plant breeding, though it may not seem of much importance sociologically. Yet even as a straight human-interest subject it is by no means negligible. Mayo-Smith¹ estimated that marriages between second cousins and nearer relatives constitute about 1 per cent of the total number of marriages contracted in this country. Various estimates for continental

¹ R. Mayo-Smith. *Statistics and Sociology*. New York, 1895.

Europe, though variable, are at least as high. Sir George Darwin,¹ by an ingenious though not very precise mathematical formula, calculated that the percentage of first-cousin marriages in England was nearly 2 in urban districts, over 2 in rural districts, 3.5 among the middle classes and landed gentry, and 4.5 among the aristocracy. Arner, though believing that Darwin's figures are much too high, estimated by a similar method that first-cousin marriages vary from 0.5 per cent in the Northern and Western States to 5.0 per cent in isolated communities, and constitute about 1.0 per cent of the total. Thus, if cousin marriages, or stricter forms of inbreeding, were invariably followed by dire effects on the progeny, the result would be a rapid deterioration of the whole population. Serious evil results in only a moderate proportion of the cases would mean a great economic burden, through constant enlargement of our benevolent institutions, which already consume such a huge percentage of our revenues.

Every sickness, physical abnormality, or mental defect not easily accounted for otherwise has been ascribed to parental consanguinity. And the truth is, such afflictions have followed consanguineous matings rather frequently. On the other hand, numerous marriages between unrelated persons have been stigmatised in exactly the same way. For this reason one ought to delimit the problem with care. It may be stated in three questions: Are the children more frequently unhealthy when the parents are related than when they are not related? Is a consanguineous union, irrespective of the genetic constitution of the parents, a cause of calamity? Can a genetic interpretation of all the facts be given which is independent of the question of blood relationship between parents?

It is doubtful whether the generalities on this subject which glitter from the pages of so many books and papers

¹ G. H. Darwin. "Marriages of First Cousins in England and Their Effects." *Jour. Stat. Soc.*, London, 38: 1875.

have any value. Cases can be cited to support each of the theses commonly advanced. Two of the finest subraces the world has produced, the Spartans and the Maoris, were endogamous; some of the lowest types of humanity followed the same marriage system. Similarly, exogamous races were sometimes distinguished by their physical perfection, and sometimes notable for their weakness. A score of isolated communities, where close intermarriage is the rule, have exhibited long histories of a truly remarkable freedom from physical and mental defect. Among them may be mentioned the Pitcairn Islanders,¹ descended from a group which in 1800 consisted of 1 man, 5 women, and 19 children; the Batz community in Loire-Inférieure, which has gone its way without hereditary defect for centuries; the Hindu community of the Tengger Hills in Java, said to be inhabited by the largest and strongest race in the country; the various racial islands of Great Britain investigated by Doctor Beddoe; the Smith's Island Colony of Maryland studied by Arner.² Tally for tally, other communities can be cited where defectiveness of various kinds is greatly in excess of what is found in the general population. One need only mention³ the feeble-mindedness of the so-called Hill Folk of New England, the 11 per cent of deaf-mutes among certain families of Martha's Vineyard, the 13 per cent idiocy and 7 per cent insanity at Point Judith, the blindness and feeble-mindedness prevalent in certain of the Bahama Islands, the high frequency of dwarfism on one of the peninsulas of Chesapeake Bay.

From this mass of contradictory evidence it is impossible to answer the hypothetical questions propounded. Nor is it possible to get a true clinical picture by studying gross sta-

¹ See Huth, *l. c.*

² G. B. L. Arner. *Consanguineous Marriages in the American Population. Studies in History, Economics, and Public Law. Columbia University*, vol. 31, 1908.

³ See C. B. Davenport. *Heredity in Relation to Eugenics*. New York, Henry Holt, 1911.

tistics which have a measurable degree of precision, for the effects of the various factors concerned cannot be isolated and given their proper weight. Yet these data are not without their value. They give us a rough comparison between the characteristics of inbred families and those of the general population. They give a grouping of massed causes and the resulting effects.

It is commonly believed that consanguineous marriages show a lower fertility than other marriages. As a generalisation this is probably incorrect, though I have no doubt that it holds for certain families. Sterile marriages form about 10 per cent of the total in young, vigorous countries like Australia. In some of the older countries, where there is little immigration and considerable emigration, they reach about 20 per cent. Similar percentages are found for consanguineous marriages. The statistics of Bemiss¹ for consanguineous families, in reality a selection biased in favour of disease and abnormality because reported by physicians, show less than 7 per cent. A few rather fragmentary data from continental Europe give a figure of about 18 per cent. Where comparable populations are contrasted, such differences as exist are seldom statistically significant; and where they do appear to be significant, they do not favour either side of the argument consistently. The best study is probably the work of Sir George Darwin, who found a slightly higher sterility rate in consanguineous marriages.

As to relative fertility, though several continental investigators have found marked differences, sometimes favouring the consanguineous marriages and sometimes favouring the others, the most precise and best-analysed cases show no trustworthy differences. In Darwin's data for England one finds an average of 2.26 sons per marriage where the parents are unrelated, and 2.43 sons per marriage where the parents are first cousins. In Arner's American statistics, which included 617 fertile consanguineous marriages and 970 fertile

¹ S. M. Bemiss. "Report on the Influence of Marriages of Consanguinity Upon Offspring." *Trans. Amer. Med. Assn.*, 41: 319-425, 1858.

non-consanguineous marriages, the average number of children in each was 5. Even Bemiss's selected data for middle nineteenth-century Ohio showed only a very slight difference in favour of non-consanguinity.

When one takes into consideration the question of pathological conditions, however, Bemiss's data are a pretty sad lot. He had records of 3,942 children of consanguineous parents, 1,134 being defective. Of these, 145 were deaf-mutes, 85 blind, 308 feeble-minded, 38 insane, 60 epileptic, 300 scrofulous, and 98 deformed. But it must be remembered that these cases were furnished solely by physicians whose attention would be attracted only by the observation of anomalies. The same difficulty is met in a very large proportion of the total statistics compiled to date. Nearly all are institutional studies or records of physicians where the primary reason for looking up a case is usually the casual record of a defect.

Yet there is some valuable evidence. Take, first, the extended statistics of Mayet¹ on mental disorders in Prussia during the latter part of the nineteenth century. Of patients suffering with simple insanity (his terminology, not mine), 6.5 per thousand were the offspring of consanguineous matings; of the paralytic insane, 4.1 per thousand; of the epileptic insane, 5.6 per thousand; of the feeble-minded, 14.4 per thousand. Thus, since at least 6.5 per thousand of Prussian marriages have been found to be consanguineous, a somewhat greater proportion of defectives have closely related parents than is to be expected if defectiveness is distributed at random.

One obtains the same idea from the work of Fay² and Bell³ on blindness and deafness, based upon the figures of the United States Census of 1900.

Bell addressed a genetic questionnaire to the 101,123

¹ Quoted from Arner, *q. v.*

² E. A. Fay. *Marriages of the Deaf in America*. Washington, Volta Bureau, 1898.

³ A. G. Bell. *Special Report on the Blind and Deaf*. Issued by the U. S. Census, 1900. Prepared under Doctor Bell's supervision.

blind persons enumerated, and received replies from 64,763. Roughly, half of these were totally blind and half partially blind, but this need not concern us here. That blindness is often hereditary is shown by the frequency of blind relatives, making due allowance, of course, for duplication of relationship through replies by related persons. 10,967 answers, or 19 per cent, reported blind relatives, and about 80 per cent of these were brothers, sisters, or ancestors. Of the 56,507 cases answering the questions regarding the relationship of the parents, 2,527, or 4.5 per cent, reported cousin marriages, and 39.3 per cent of these reported blindness in sibs or ancestors. 25 per cent of the blind of consanguineous parentage were congenitally blind, and over half of them had blind relatives of the degrees noted. Only 6.8 per cent of the blind from non-consanguineous parents were congenitally blind, and of these only 28 per cent had blind relatives of these degrees.

The data on 89,287 deaf persons replying to similar questionnaires are very much like those on the blind. There were 14,472 cases classified as congenitally deaf, though it is probable that some of those listed as deaf through disease or accidents actually belonged to this group. Of the congenitally deaf, 11.8 per cent were the offspring of consanguineous marriages, while of the adventitiously deaf, only 3.1 per cent were thus reported. Of those whose parents were cousins, 53.4 per cent had sibs or ancestors who were deaf; while only 29.9 per cent of those whose parents were not cousins reported deaf relatives of the same degree.

Huth compiled the reports of 14 investigations on deafness in which all the way from 4 per cent to 30 per cent were reported to be from consanguineous marriages. And Stieda, in an extended investigation of French statistics, found that the proportion of people bodily and mentally infirm increased in the various Departmental Divisions as the proportion of consanguineous marriages increased. The increase was not in the proportion to be expected on the basis

of cause and effect, however, for 34 Departments, averaging about 8 consanguineous marriages per thousand, had approximately 2.8 infirm persons per thousand inhabitants; and 32 Departments, averaging about 16 consanguineous marriages per thousand, had roughly only 3.3 per cent infirm per thousand inhabitants.

If one weighs the results of these and of other similar researches carefully, making due allowance for the bias caused by the special selection of cases to be recorded and other errors of method, and giving consideration to the cases where intensive inbreeding is known not to be followed by evil results, he can hardly avoid the conclusion that physical and mental infirmities are from two to three times as frequent among the offspring of related parents as they are among the offspring of unrelated parents. This estimate naturally is not precise, but it expresses roughly the difference between consanguineous and non-consanguineous marriages in expectation of defective offspring. I believe it to be sound, in spite of the fact that the most extended investigation of this kind, that of Sir George Darwin, based on English statistics, is rather adverse to this view. Sir George found no greater proportion of infertility, congenital deafness, insanity, or feeble-mindedness in the families of first cousins than he did in other families, but he did observe a lower vitality, which expressed itself in a higher death-rate. The discrepancy lies, I think, in the faulty method he used in determining the frequency of cousin marriages in the general population. There is good reason to believe that a more precise calculation of this proportion would lower it by half, thus bringing his results in line with our conclusion.

This is all very well. We have a tentative answer to one of our questions, but this answer gives us no information on the other problems. We begin to suspect, however, since some inbred families are uniformly excellent and others inclined to show defectiveness, that heredity and not consanguinity *per se* is the cause of the observed results. The sus-

picion is well grounded, but it is difficult to confirm it by citing only the direct evidence on human matings. Such evidence is too fragmentary and faulty. In one of Wiggam's books, *The Fruit of the Family Tree*, he has a chapter entitled "What Cousin Marriages Tell About Heredity"; yet if he had written squarely up to the title, he would have had little to say. Cousin marriages tell us next to nothing about heredity. But knowledge of the mechanism of heredity does enable us to interpret the conflicting data obtained from cousin marriages—to fit them together like the parts of a picture puzzle.

As the accumulation of biological facts reached massive proportions during the nineteenth century, belief in the evil effects of inbreeding became more and more firmly fixed. The more mystical convictions of earlier days appeared to be confirmed by science. A survey of animals and vegetables showed that all but a negligible fraction of the species were provided with mechanisms effective in promoting cross-fertilisation. And species which were invariably self-fertilised were often lowly and degenerate relics. Darwin and some of his contemporaries, observing these facts, asked themselves the same question that we have propounded here; namely, whether inbreeding is of itself an evil thing. And finding by experiment that certain inbred plants decreased in size and diminished in fertility, they voted in the affirmative. Though Darwin realised that inheritance had something to do with the matter, he retained faith in the older view-point, and was led thereby to one of his few serious errors. He laid down the law "Nature abhors perpetual self-fertilisation," and believed that all self-fertilised organisms would degenerate and ultimately disappear.

The true interpretation of the facts, as Weismann first suggested, is that cross-fertilised plants and animals are merely many times more variable than those which are self-fertilised; hence, they have a better chance to survive. In spite of the handicap in making their way through the cen-

turies, a considerable number of plants, like tobacco, wheat, sugar-cane, and banana, have lived long and prospered with only an occasional cross-fertilisation; but, still, they are plants. The animals reached the top of the ladder of life, and on the higher rungs are found those which clung to bisexuality, and, therefore, to cross-fertilisation. Inbreeding had its shortcomings, though they were not those assumed by Darwin. His law should have read: Nature finds a great advantage in an occasional cross-fertilisation.

Darwin's work aroused great interest in the study of inbreeding, and during the latter part of the nineteenth century many series of experiments were carried out, with small mammals and plants as material. But the way to precise analysis had not yet been opened, and little progress was made. Then came the rediscovery of Mendel's paper, bringing with it a revolution in genetic methods; and within a few years the problem was a problem no longer.

The most extended researches¹ on inbreeding are those on Indian corn, which were begun by the writer in 1905 and have been continued during recent years by H. K. Hayes and D. F. Jones. Indian corn was selected for investigation not altogether because it is an important American crop plant, but rather because it is a naturally cross-bred, hermaphroditic plant known to be affected adversely by continued successive self-pollinations.

A hermaphroditic plant, that is to say, a plant which has both male and female organs in the same individual, is particularly advantageous in this sort of work. The female flowers can be pollinated with pollen produced by the same individual, a system of mating which is manifestly the most intensive type of inbreeding possible. With this mode of inbreeding, simple mathematical tests can be made which show just what is going on genetically within the variety.

What did happen in the dozens of varieties tested? Sim-

¹ E. M. East and D. F. Jones. *Inbreeding and Outbreeding: their Genetic and Sociological Significance*. Philadelphia, Lippincott, 1919.

ply this. The finest-looking, most healthy commercial varieties were found to carry a really remarkable number of deleterious recessive characters, which remained covered up by the effects of their normal dominant mates until inbreeding unmasked them by bringing together two germ-cells having the same trait. There were albinos and near-albinos of some twenty different sorts, there were dwarfs of various types, there were defective seeds by the dozen, there were abnormalities of leaf, stem, flower, and fruit. And these undesirable characteristics, when isolated, were found to be inherited according to the regular rules of the game. During the earlier years of inbreeding, these family black sheep were discovered in great numbers, and were taken out, done away with, eliminated. Then, as generation succeeded generation, they appeared less frequently and still less frequently, until the variety was freed from their contamination, purified.

During this period the variability of the varieties tested gradually diminished, this decrease in variability itself growing less and less with each succeeding generation until each type under observation grew constant, unchangeable. Each race bred true. And from this point on, "the dire effects of inbreeding" ceased. Self-pollination followed self-pollination without the slightest indication of further deterioration. And the course taken by these changes, at first rapid, then slow, then slower still, until measurable change had ceased, was exactly the course that mathematical calculation demanded if the sole mysterious effect of inbreeding is the isolation of recessive characters.

Inbreeding had yielded up its secret. In and of itself it has no effect whatever on a family, whether that family be maize or man. It is a mechanical process, so functioning as to bring together like germ-cells more frequently than other methods of breeding. These germ-cell duplicates from the two sides of the family may carry good characters or bad characters, but the process itself is not to be blamed if the result is bad.

The diversity of types produced by inbreeding depends directly upon the number of heterozygous hereditary factors present in the individuals with which the process is carried out; it varies in proportion to the amount of cross-breeding in the immediate ancestry. The function of inbreeding is the isolation of homozygous types, which proceeds more rapidly or less rapidly according to the intensity of the mating system. If the strain under observation is naturally self-fertilised, a true-breeding strain such as tobacco, homozygous for practically all of its hereditary factors, then inbreeding has no effect at all. Cross-bred strains arrive at a similar condition of stability in time, the time being longer or shorter according to the intensity of the inbreeding; and it is solely during this process that inbreeding gets in its work—the isolation of homozygous types.

Doubters may question the justness of drawing general conclusions from experiments on Indian corn, and their conservatism would be proper and commendable if no other evidence were available. But we must not forget the fact that all of the higher organisms have the same heredity mechanism. This fact alone makes it highly probable that inbreeding functions similarly in all cases. And if a superabundance of proof is demanded, there are dozens of experiments on mammals available for study. Those of Doctor Helen King on rats and of Doctor Sewall Wright on guinea-pigs are especially recommended to the sceptical. Wright, in particular, has demonstrated conclusively, by rigorous mathematical tests, that the observable effects of inbreeding are confined to the particular distribution of hereditary characters called forth by the system of mating. They are due to heredity, wholly and solely to heredity.

The traits exhibited by inbred families, therefore, depend upon the chance allotment of characters pre-existing in the stock before inbreeding is commenced. If undesirable characters crop forth after marriages between near kin, it is because they were in the strain as recessive traits protected and kept from sight by the more favourable characters

which dominated them. If inbreeding plays us tricks, it is because of the dual nature of our heritage, the double set of genes which each individual possesses, the one from the father, the other from the mother.

What, then, shall be said of cousin marriages? Are they desirable or undesirable? In general they are undesirable. Inbreeding is a powerful tool for the plant breeder and animal husbandman. By using it, existing traits can be strengthened, varieties can be made uniform. Intermarriage of relatives in the human race has a similar effect. By it, strong, healthy families, with few undesirables in their germ-cell stock, have been made stronger and healthier. But objectionable recessive traits are common in the human race just as they are in maize—particularly defective conditions of the nervous system. Under the circumstances, therefore, one had best be careful, extremely careful. If a marriage between cousins is projected, the “fruits of the family trees” should be scrupulously examined for traces of muscular abnormalities, blood abnormalities, dwarfism, feeble-mindedness, and insanity. If persons afflicted by any of these defective traits are found either in direct or collateral lines within four generations, the projected marriage is inadvisable.

Opinion to-day is not markedly different from that expressed by Noah Webster,¹ the lexicographer, who was the first American writer on the subject. But we can state it with more conviction. We have the proofs. “Near blood connections often produce imperfect children. The common people hav hence drawn an argument to proov such connections criminal; considering weakness, sickness and deformity in the offspring az judgements upon the parents. Superstition iz often awake when reezon iz asleep.”

¹ N. Webster. “Explanation of the Reezons why Marriage iz prohibited between Natural Relations.” *Collected Essays*. Boston, 1790. Quoted from Arner

CHAPTER IX

RACIAL TRAITS

DURING the years elapsing since the close of the Great War, a tidal wave of race consciousness has engulfed the peoples of the earth. In every clime there appears to be a fixation over race, or, to speak more precisely, over what is supposed to be race. Its obvious symptoms, the throaty roars for rights by minorities, the threats and counter-threats by majorities, the fanfaronades of dictators, the tactless ultimatums issuing daily from Foreign Offices, might seem to indicate merely the prevailing fashion in political stage effects. On the contrary, these events seldom represent the antics of political contortionists acting as individuals, they are the result of a concept deeply impressed on the massed minds of humanity. One suspects that the lunar directrix of the phenomenon is Wilson's shibboleth "self-determination," which, a decade ago, was broadcast to every hamlet of the globe.

The idea is not new. There have been Chosen Peoples before. But according to Lord Bryce, whose opinion as an historian deserves respect, it has played only a small part in the bickerings of the past. People fought for plunder in the form of land, goods, or commercial supremacy, to indulge the ambitions of their rulers, and for religion, but hardly ever because of racial solidarity or racial hatred. The reason is not far to seek. The arrogance of earlier days was confined to special classes of the population, and could hardly have been a general stimulant of strife except in patriarchal tribes and possibly in some of the ancient republics. For the superiority complex to be an effective catalyst among the people as a whole, democracy must be firmly in the saddle. This is why it was not a potent force

in world politics until the middle of the nineteenth century, at which time it became an important influence in the consolidation of Germany and of Italy. A little later it spread to southeastern Europe, then easterly to Egypt and Japan. To-day it is world-wide.

Huntington¹ is persuaded that the doctrine is destined to play a great part in history during the next few generations, and there is no good reason for gainsaying this conviction. More questionable is his opinion that the truth concerning race, whatever it may be, if logically expounded, will seep downward until it permeates the masses and becomes in turn a political determinant. Le Bon, as Huntington himself notes, has shown that the truth or falsity of a tenet has little to do with its ascendancy over the group mind. Truth itself can hurt.

The problem of racial development and differentiation, though pre-empted by anthropology, is fundamentally a genetic problem. It can be given a sound and philosophically satisfactory solution in genetic terms—sound because the solution is based upon established genetic principles, and is supported by the data of archæology and history, rather more satisfactory to the philosopher than to the materialist because it can be couched only in general terms, like an actuarial statement, and therefore does not offer a concrete answer to every practical question.

Strictly speaking, the current furor over race does not always concern race. What has been called race consciousness is often merely a spirit of intense nationalism, a politico-social phenomenon. The fact will make little difference to those who hold the delusion, but the following personal experience will show that there is a distinction.

Not long ago a statement of mine concerning the low average in capacity exhibited by immigrants from southern Italy was unfortunately taken as an attack upon the inhabitants of that portion of the globe in toto. My mail-

¹ Ellsworth Huntington. *The Character of Races*. New York, Scribners, 1924.

box was glutted with caustic epistles. Among them was a choice letter from an irate Neapolitan which contained these words: "My ancestors did their level best to civilise your half-naked, barbarian ancestors, but the more I read of you the more I think they made a bad job of it." The writer was fairly entitled to cry "Touchez!" had he delivered this riposte and rested; but by way of rubbing salt in the wound, he made the mistake of naming twenty-five great Italians as his ancestors, and asking me what names I could pluck from my own family tree to make as good a showing. He did not realise that twenty-one of these twenty-five great ones of earth were long-heads from between Piedmont and Tuscany whose ancestors were chiefly these same barbarians who had drifted from the north through the snowy passes of the Alps, there to leave the seed for an Italian Renaissance. Had he compared his own features with those appearing in *La Scuola di Atene*, where Raphael has portrayed so many of the notables of his time, his letter might have been phrased differently.

Perhaps in the light of such a precedent, tributes to the memory of the Colonial Fathers will some time come to have a more intimate meaning to the descendants of Charley Wang, who to-day irons our shirts so neatly. From a nationalistic point of view it is a consummation by no means undesirable, though it might make matters a little difficult for the Colonial Dames and the American Genetic Association.

One who endeavours to visualise the genetic basis of history is often misunderstood. This is the cross of the specialist. Because he must emphasise the factor he undertakes to consider, it is assumed that he neglects all others. In Hankin's excellent essay on Sociology, written as a part of *The History and Prospects of the Social Sciences*, edited by Barnes, there is a tentative classification of writers in this field under five headings, viz., geographical determinists, biological determinists, psychological determinists, cultural

determinists, and social philosophers, idealists, and reformers. Under subheadings are listed those who emphasise primarily migration, climate, food, and natural resources, natural selection, hereditary traits, instinct, reason, collectivism, and so on, all of which must have been effective in the development of man as the social being we see to-day. Some of these students were narrow and prejudiced perhaps, some may even have been ignorant of existing evidence on the fragment of the subject of which they presumed to write; but it is quite likely that the majority emphasised one factor of social evolution to the exclusion of others as a mere matter of expediency.

Obviously, all of these factors, important as each may be, fall into two groups. We are again concerned with heredity and with environment, each playing its definitely appointed rôle. Again heredity is the primary requisite, the substructure. Its importance cannot be ignored or minimised. Belief in its influence must follow if one accepts the doctrine of evolution—and is able to reason. There is much to which one might take exception in the works of such extreme advocates of racial determinism as Gobineau, Chamberlain, Lapouge, Grant, Stoddard, and Gould. These writers are often uncritical in their acceptance of evidence. At times they are passionate dogmatists. Their unfamiliarity with genetic facts is patent. Nevertheless, these admissions do not disturb the fundamental soundness of the position that genetic variation is a prerequisite for social progress. And when this position is stated with judicial discretion by respected and respectable scientists who have made a special study of the facts, men like Galton, Pearson, Davenport, Conklin, Lenz, and Ploetz, it is not a matter for amateurs to dismiss with a cursory wave of the hand. Nor does it help scientific evaluation of the elements contributing to produce racial qualities, for serious students of anthropology, such as Boas, Dorsey, Goldenweiser, and Kroeber, to deny the validity of genetic generalisations when

unfamiliar both with their character and with their factual basis.

For the sake of clarity, we shall present the conclusions to which genetic philosophy leads before proceeding to give a brief argument concerning the archæological and historical evidence.

Existing representatives of humanity belong to a single species, *Homo sapiens*, as shown by the facility with which they interbreed and give fertile progeny, by chemical blood tests, and by many other less important criteria. It is a variable species, nevertheless, presenting an extraordinary range of characters, including as characters both physical and mental attributes. This variability is due in last analysis to constitutional changes in the genes which, as we know, are inherited alternatively. The great majority of genes carried in the 48 human chromosomes must be assumed to be common to the species, but a sufficient number have mutated to produce profound changes in both body and mind.

During the early part of human evolution, circumstances were such as to form distinct subspecies. These subspecies exhibited that variability without which continued progress would have been impossible; yet each group bred more or less true to its distinctive characteristics. No one of these races could be said to be higher than another in the sense of being further removed from the apes in all of its peculiarities. They were simply different. And as they differed in their other organ systems, so also did they differ in their central nervous systems, their powers of intelligence.

At a later period these subspecies, varieties, races, or whatever one wishes to call them, came more and more into contact with one another. They interbred. The result, through hereditary recombination of the genes, was an increase in variability. No longer could the different types be segregated easily. Race origin might still be traced, but the overlapping of traits was much in evidence. One may

see how the situation was changed through interbreeding, by the consideration of one physical trait—skin colour. The negro and the Caucasian both exhibit some range in skin colouration, but they seldom overlap. Cross-breeding, however, changes all this. After a period of intermixture, individuals of mixed ancestry can be found who are as white as the palest of the white race, together with others who are as dusky as the darkest of the black race. And so it is for every character by which the races differ. This is the trick played by alternative inheritance. The results of such an experiment, carried out on a grand scale, are visible in India.

This matter of race-crossing was fraught with grave consequences. Through natural selection the ancient races had become smoothly running colonial organisms, exhibiting sufficient variation to cope with the difficulties confronted in their natural habitats; but their evolution was slow, an almost imperceptible advance. Crossing broke up these harmonic wholes, and speeded up the evolutionary process at a truly tremendous rate. But a price was exacted for its benefits. *Extreme variability, through the recombination of genes, produced a higher grade of men than the world had ever known before at one end of the frequency curve, and a lower grade at the other.*

Bizarre as it may seem, this is the result to be expected on theoretical grounds when interbreeding occurs between two races physically and mentally comparable, yet genetically different. The increased variability, the greater spread of the racial curve, which must ensue under such conditions, brings more men of iron and more weaklings, more geniuses and more ne'er-do-wells on the stage. Is it not reasonable to suppose that this was rather a new thing in human history? Under conditions of savagery, intellectual giants might have been tolerated, even if they were respected no more highly by the mob than they are to-day, but any great proportion of subnormals would have been as disastrous as a high per-

centage of invalids. At the same time, it should be pointed out that all race-crossing does not necessarily mean progress. A "low" race may have nothing genetically valuable to contribute to a "high" race, either physically or mentally. In such an intermixture variability will be increased as before, yet neither the major extreme nor the average will reach that displayed by the higher component of the cross.

J. A. Mjølten¹ has protested vigorously against the idea that race-crossing is often beneficial. From a study of the inhabitants of Norway, he concludes that intermixture between such substantially different types as the Nordics and the Finns produces disharmonic combinations less desirable than either of the component races. The figures for tuberculosis, he says, are smallest in that part of Norway where the Nordics are comparatively pure, and largest in that part where race mixture is the greatest. So also for social inadequacy. Perhaps his whole argument may stand as regards the Nordics and the Finns. But he forgets that creative artists of all kinds are also found in lower proportion where the Nordics are comparatively pure, and in greater proportion where intermixture with other good races has given the opportunity for the necessary genetic recombination. A study of portraits of the great and the near-great of the Scandinavian countries has convinced me that there is more genius in the somewhat mixed type than in the apparently pure Nordic. It may even be said that the intellectuals contributed by Sweden and Norway, where the Nordic is seen in greatest purity, are not quite so numerous in proportion to the population, or of quite such high rank, as those of Britain, France, and Germany.

Most students of human evolution assume that change was at one time much more rapid than it has been during the historical period. As regards genetic variation in the strict sense, this is probably true, since there are no records

¹ J. A. Mjølten. *Harmonic and Disharmonic Race Crossings. In Eugenics in Race and State.* 2 vols. Baltimore, Williams & Wilkins, 1923.

of recent mutations. But though evolution depends ultimately on mutation, for a limited period recombination of genes can make it more of a high-velocity affair when there are numerous genetic variations to furnish the material and perfect interfertility to allow the machinery to act, which is just the situation in man. Some anthropologists also assume, on purely speculative grounds, that there has been no change in mentality during the last 50,000 years. Cro-Magnon man, they aver, had as large a brain-pan as any modern race. Not satisfied with this modest generalisation, they go further and conclude that the apparent superiority of a given race at any period is due solely to general social conditions. Could deduction go to more absurd lengths! Do these people really suppose that Shakespeare, Newton, and Darwin owed their ability to the size of their skulls? Were this true, what megacephalic monstrosities they would have been! Or can they seriously maintain that sixteenth-century Europe, when 90 per cent of the people were illiterate, furnished an exceptionally nutritive medium for the culture of genius? If so, democracy has failed.

Let us make our own postulates a little more in keeping with reason, and perhaps the effects of race-crossing in human evolution will become a little clearer. The last steps in human progress have been taken with seven-league boots. In five or six thousand years man has been transformed from a stone-wielding biped engaged in a physical struggle with the rest of the universe to a commanding figure ruling by his brain. Why? Because a mere handful of supermen, a few thousand altogether, had the mental ability to make discoveries. The rest of us have profited, earlier by word of mouth, more recently by the printed page. Now whatever part of their accomplishments may have been due to the opportunities furnished by social conditions, these men were what they were primarily because of their genetic constitutions. They represent the extreme of the frequency curve, where the combinations of hereditary factors called genius occur.

Supreme leaders of civilisation are rare. Inferior races have produced none, superior races have produced but a few score. In general, there is perhaps 1 for each 100,000,000 of the population. From the genetic point of view the reason is perfectly clear. Of the thousands of genes necessary to produce any kind of a normally functioning mind, some hundreds through mutation are not common to all the individuals of the species. One race may have more Grade A genes than another, yet the second race may have some good genes not possessed by the first. The possibilities of each race when existing in isolation are limited to the recombinations of their own genetic differences. Let intercrossing occur, however, and the potentiality for grouping Grade A genes into the combination we call a genius is materially increased. Genius, having no survival value, will always be rare, but it will occur more frequently in mixed races than in "pure" races, provided the components of the mixture furnish desirable supplementary genetic factors.

This visualisation of human genetic history is avowedly speculative, but less so than the current anthropological theories, for it has critically determined laws of heredity for its basic postulates. Its logic is inexorable. In its broader aspects it simply must be a true picture. It possesses, moreover, the advantage of giving a reasonable interpretation of the rise and fall of civilisations, an historical fact which has been a stumbling-block to the older theories.

What made the glory that was Greece—or India, or China, or Egypt? Their great men, a few dozen, at most a few hundred. It is a mistake to suppose that greatness was an attribute of these countries as a whole. Those who had genetic blessings, always admitting the necessity of the opportunity to display them, were the glories of each civilisation. And genius, unfortunately, shows no biological fitness. It tends to die out as do all extremes which are not physiologically useful.

The general attitude of society towards creative work may have had much to do with giving a Golden Age to Greece,

a Renaissance to Italy, an Elizabethan period to England, a Napoleonic Era to France; but the essential requisite for each was the inherent greatness of a few individuals, a biological greatness which passes, leaving us to mourn. Were this not true, why is it that Italy and Greece are but shadows of their former selves? Can any one seriously maintain that either country, now immensely expanded in population, does not give the same opportunities for creative work that it gave some centuries ago? Galton concluded that the ablest race in history was built up in Attica between 530 B. C. and 430 B. C., when from 45,000 free-born males surviving the age of 50 there came 14 of the most illustrious men of history. To-day we look at Greece, and with incredible naïveté ask why Greece has fallen from her proud estate. The answer is simple. The Greece of to-day is biologically different from the Greece of Pericles. The peculiar combinations of germ-plasm which gave her a commanding position have segregated out and disappeared.

We are not now and never will be able to trace the development of mankind with meticulous precision. Too much of the evidence is circumstantial. Yet with the generalisations of the evolutionists and the geneticists as working hypotheses, the facts of geology, archæology, ethnology, and history combine into a fairly accurate picture. Ellsworth Huntington has sketched this picture for us extremely well in his notable work, *The Character of Races*. Here we can consider only a few of the salient points.

It is generally agreed that man originated somewhere in the part of central Asia now covered by deserts and plateaus. From there successive streams of pioneers went westward to Europe and Africa, southward to India, southward again to Australia by way of the Malay peninsula and the great Pacific islands, eastward to China, and northeastward, by way of Alaska, to the Americas, leaving trails which those trained in the art can read.

These great treks began some time ago, as we are accus-

tomed to think of time. Types truly human in their aspects date back to the Pliocene era of geology, half a million, a million, perhaps two million, years. During this long period there was time for many things to happen, and many things did happen. The earth changed, the climate changed, the people changed. Seas closed up and became dry land, portions of continents sank and disappeared, plains became mountains, mountains became plains. As a resultant of these geographical transformations, though there were other causes also, the climate was altered, both locally and generally. The mild conditions of the Miocene gradually gave way before the onset of the great Ice Age; then gradually again there was a return to conditions as they exist to-day; and races of people having different traits appeared.

It has not been possible to date the appearance of man in various parts of the world very accurately, but it is fairly certain that great parts of Asia and the islands to the south, the southern portion of Europe and various regions in Africa, were inhabited before the glacial period. The Americas were presumably the last great areas to be settled, but whether the immigrants came in before or after the Ice Age is still uncertain. The circumstantial evidence, the wonderful civilisations of Central and South America, makes the earlier date more probable, and one may expect to hear of critical proof at any time.

Here is man, then, wandering about the earth for half a million years or more, a period perhaps 100 times as long as that of which we have recorded history. He survived. Why? He was an adaptable species, and varied to meet the extraordinary conditions he encountered. It takes a great effort to imagine the struggles of prehistoric man with his environment, buffeted by wind and wave, stifled with heat, congealed with cold, under slanting light rays in the polar regions, surfeited with ultra-violet at the equator, here penned up by mountain ranges, there wandering over great stretches of territory, sentenced to a particular diet

in one part of the earth and to a wholly different diet in another, attacked by wild beasts continuously, decimated by disease in every generation. Natural selection was at work with a vengeance.

We may be quite certain that if the little packets of genes with which the human career was started had been a little more conservative, a little more stable, man would long since have disappeared. But they met the requirement—they varied.

It is important to realise the effectiveness of this long Isolation Period in differentiating mankind into distinct groups. Every variation in environment and every change in culture presumably had its effect. Hundreds of genes took on new constitutions. The result was a series of subspecies, the precise number or type of these being of no importance. We can visualise them by Blumenbach's old skin-colour classification if we wish, ridiculous as it is; but we must not make the mistake of supposing that such paltry distinctions as skin colours were the chief differences exhibited. The form and colour of hair, eyes, and skin varied in striking ways, it is true; yet these characteristics are only indicators, so to speak, of extraordinary changes taking place in the whole body, changes which are perhaps most easily noted as variations in the skull and other parts of the skeleton. We call mankind a single species only because the extreme variants are interfertile. If anthropologists were to disregard this one test, they would be forced to describe several species, though they would be more or less hypothetical species if the attempt were made to-day, because of interbreeding in the past.

Since man has varied in such an extraordinary manner physically, it is not logical to suppose that he has remained fixed in his mental traits. One must assume that *Homo sapiens* is just as variable in his intellect as in his morphology. The only questionable matter is whether the average between groups with respect to intelligence is comparable to the average difference in physical attributes.

The second period of man's racial history had quite a different effect genetically. As national life became more firmly established, variation continued, and natural selection kept up its work. Huntington has shown very definitely that genetic selection has been stringent clear up to the present day. But as relatively permanent civilisations arose, the tendency was towards amalgamation rather than differentiation. Wave after wave of invaders swept from country to country along tracks definitely delimited by geographical barriers. For our purpose here it is not necessary to take account of whence they came or where they went. The important point is that hybridisation, race-crossing, has been the order of the day ever since the dawn of history. In the earlier days, conquering hordes sometimes swarmed over a fertile country like a devouring flame, consuming the natives as it swept along. But in the main, these migratory hosts, whether conquering or conquered, fused with the inhabitants of the lands they entered much as is the case with the peaceful penetration of to-day.

Anthropologists, therefore, are confronted with a difficult task. They are called upon to classify existent peoples with the twofold purpose of furnishing a useful nomenclature and of solving problems of descent. Since language and nationality are insecure bases, they have founded their systems on a combination of physical traits such as head form, skeletal relations, etc. And even these criteria are not as satisfactory as might be desired. Head shape, for example, is the most conservative measurement used, presumably because it is the product of numerous variable genes. Yet even head shape, Doctor C. R. Stockard writes me, is influenced by the activity of the thyroid gland, and this in turn is influenced by diet.

In addition, there is another difficulty. The true basis for differentiation in man, as in other organisms, is gene variation; and the inheritance of genes is alternative. Unfortunately, the genes of the human race are uncharted. They cannot be listed like the bones and muscles. One is

thus constrained to name variations by the structural units involved, and like changes may or may not be due to like gene combinations. With simple characters such as eye colour there is small likelihood of error in assuming differences in one or two particular genes. Numerous genes are necessary to produce an eye, but only a few have varied. With other characters, as, for example, the skull, an extreme amount of genetic change has occurred. It cannot be assumed, therefore, that two individuals having the same cephalic index are identical in the hereditary factors whose chief functions are the control of skull shape. Generalising from these facts, it is clear that identity in a few characters is in itself no critical evidence of close genetic relationship.

Coping with these difficulties as best they may, anthropologists have made many attempts to classify humanity, both past and present. One of the most recent is the work of Dixon,¹ who believes that skull shape is the best criterion for determining relationship. On the basis of the degree of projection of the jaws, the ratio of skull breadth to length, the proportion of height to length, and the relation between the breadth and the height of the nose, this author believes he can justify the assumption that there were eight primeval races, from which all other races were derived by crossing. The probable correctness of Dixon's conclusions is a question to be decided by specialists. They are hypothetical deductions from quantitative data, and will stand or fall in the estimation of other anthropologists according to whether they demolish more archæological and historical obstacles than they raise. And, in the end, this part of the matter will be speculative. The reason for citing the work here is to show that Dixon, like every other responsible anthropologist, agrees that during the early part of human evolution there was differentiation into distinct types of relative genetic purity, and that the races of to-day have lost this definiteness through intermixture. Our own imme-

¹ R. B. Dixon. *The Racial History of Man*. New York, Scribners, 1923.

diate problem turns upon the question whether all racial grouping is now impossible. It seems a stupid question to any one who has travelled and kept his eyes open, but more than one ethnologist has held the classification of existing peoples up to ridicule because at one end of the curve Mongolians and Amerinds are indistinguishable, while at the other end of the curve Mongolians and Caucasians may be confused.

Let us consider the races of Europe, for the purpose of argument. The principal types, as usually distinguished, are the Nordic, the Alpine, and the Mediterranean. To these, Nordenstreng,¹ the eminent Swedish anthropologist, adds the East Baltic, which corresponds to Sergi's Finnish race, and the Dinaric, which occurs in its greatest purity in the Dinaric Alps of Dalmatia. There are also some minor groups.

Now why do students sometimes argue gravely that there is no such thing as a Nordic race or a Mediterranean race? The difficulty is supposed to arise from the fact that in any series of characters used as a means of distinction the classes overlap. But this difficulty is common to all organic classificatory systems. The reason there are phyla, orders, families, genera, and species in zöological taxonomy is because each smaller division can be grouped into the next larger category through characters possessed in common. Man belongs to the genus *Homo* containing extinct species other than *sapiens*. He is also a primate, a mammal, a vertebrate, a chordate, an animal. Probably less will be made of this strait when physical anthropologists have made a more thorough census of the world's peoples. It is a negligible matter, anyway, for gross distinctions. In spite of interbreeding, 90 per cent of the people of Sweden and Finland can be classified into two types, which may well be called Nordic and East Baltic, by the rankest amateur.

¹ Rolf Nordenstreng. In *The Racial Characters of the Swedish Nation*, by H. Lundborg et al. Upsala, 1926.

The real hindrance to work of this kind has been erroneous points of view. Nearly all of the workers in this field have failed to provide themselves with genetic spectacles, and any other optical instruments distort the vision. It is logical to distinguish races, subraces, and even families, whose average difference in certain characters makes each group something of a biological entity. The essential matter is to keep in mind that the true units of distinction are the units of heredity. Then each division will be seen for what it is, a plastic biological group set up empirically, but having a usefulness withal that is not to be decried. If this is done, the effects of isolation, of environmental change, of social change, of intermixture, of inbreeding, of differential birth-rates, of slavery, of systems of government, can at least be appreciated and traced qualitatively even if they cannot be evaluated quantitatively. Without this point of view one is wholly at sea. As proof, I advise the reader, when he has obtained an introduction to genetics, to reread Gibbon's *Rome* and Buckle's *History of Civilization* with this point in mind. He will get a new satisfaction, a feeling that he can read between the lines and discern causes which before were hidden.

Long before any genetic laws had been formulated, the Belgian statistician, Quetelet (1835), published a work entitled *Sur l'homme et le développement de ses facultés*, in which he endeavoured to show by concrete measurement that both the physical and mental qualities of man vary widely around the mean result in the same manner that errors of physical observations are distributed. Naturally, he had some trouble, as we do to-day, in proving the precise amount of variability exhibited by mental qualities; but in his later work, *L'Anthropométrie*, the amount and type of distribution for certain physical measurements were calculated with a precision hardly exceeded since.

To-day we have millions of such records both for physical and for mental attributes. We can compare races and can

calculate the variability within a race for any measurable character. The result is roughly as follows: if the measurements of each race, for any character, are divided into about 20 equal-sized classes, the average difference between races may range from a vanishingly small figure to a figure as high as five of these classes. The variability within a race, therefore, greatly exceeds any difference between races. Genetics tells us why we should expect such results, for mental as well as for physical characteristics, but it is interesting that the logical mind of Quetelet deduced the fact on purely anthropological grounds.

To Francis Galton rather than to Quetelet, however, the first attempt to evaluate the mentality of men must be ascribed. He was our first intelligence-tester. In the preface to the first edition of *Hereditary Genius* (1869), he says:

The idea of investigating the subject of hereditary genius occurred to me during the course of a purely ethnological inquiry into the mental peculiarities of different races; when the fact, that characteristics cling to families, was so frequently forced on my notice as to induce me to pay especial attention to that branch of the subject. I began by thinking over the dispositions and achievements of my contemporaries at school, at college, and in after-life, and was surprised to find how frequently ability seemed to go by descent. Then I made a cursory examination into the kindred of about 400 illustrious men of all periods of history, and the results were such, in my opinion, as completely to establish the theory that genius was hereditary, under limitations that required to be investigated.

Galton's investigations led him far and wide. By various methods of comparatively unbiassed objective judgment, he divided men into 16 grades of natural ability separated by supposedly equal intervals. We can get some idea of the meaning of the classification as he arranged it by the fact that out of a million individuals, one-half fell into the central two grades. The distance downward that this grading carries us is shown by the estimate that only 248 of the million are included in the three lowest grades. "I presume,"

he says, "that the highest type of dog is about equal to the next lowest and far superior to the lowest grade of human-kind." Similarly, the three highest grades contain only 248 individuals, yet it is from this small proportion that practically all the social advancement of man comes.

Thus the question whether man is a variable animal in respect to his mental qualities was answered in the affirmative, at least in Galton's opinion. Is this variability due primarily to heredity or to environment? On this problem the great statistician made exhaustive investigations by the only method available to him, the chances of illustrious men having relatives who become eminent. The type of genius considered by Galton occurred in a proportion of not over 1 per 10,000 of the general population, yet he calculated, from a consideration of 300 families containing among them nearly 1,000 eminent men, that the chances of kinsmen of these immortals rising to eminence are 15.5 per 100 in the case of fathers, 13.5 per 100 in the case of brothers, and 24 per 100 in the case of sons. In the third grade of relationship, the chance of each member is about 1 per 200, excepting in the case of first cousins, where it is 1 per 100.

The criticism sometimes made against these results is that the relatives of eminent men have greater opportunities than others, that the environment leading the one to eminence also led the others. For certain cases the criticism has a degree of soundness. Environment had a marked influence. But any one who takes the trouble to look over the evidence will be convinced that this theory leaves too much to be explained. Cases are numerous where relatives of eminent men lacked opportunity; they rose in spite of unpropitious circumstances. It would be more to the point to ask why the wives of the great ones did not give a downward thrust to the progeny. Galton circumvented this criticism by showing what a great amount of selective mating took place in the families of the great. Eminent men married eminent women.

Now as to the findings regarding racial averages. Galton discusses this matter at considerable length. Naturally, one must be very cautious in comparing negroes with whites, or Pygmies with Zulus. But making such allowances for conditions as appear to be desirable, the conclusion is that the negro averages about two grades lower than the English, the Scotch a fraction of a grade above, and the Athenians of the time of Pericles two grades above.

Though a heritable basis for intelligence may be inferred on general biological grounds, and the inference sustained by an appeal to history and biography, Galton's work furnished acceptable statistical proof. His methods were imperfect and therefore subject to certain just criticisms; but these criticisms do not demolish his findings. They are corroborated by the intelligence tests in current use by psychologists throughout the world.

Intelligence tests, being new developments in science, are still subject to acrimonious debate. They are, as yet, relatively unstandardised. There is no close agreement as to what measurements ought to be attempted, whether memory, for example, or imagination or attention or sensory perception should be included. The precise meaning of the tests most generally used is somewhat questionable. The accepted scales of measurement are inexact. Notwithstanding such acknowledged deficiencies, it is not too much to say that these tests measure one's ability to learn and to make conscious adaptations to new situations with a precision unapproached in testing actual imbibition of learning by the ordinary type of examination paper.

Definitions are notoriously difficult to frame, and a wordy war is being staged on the question: What is intelligence? But it seems to me that the discussion is chiefly of academic interest. All the experiences of life combine to tell us that intelligence is a creative power understandable only as a process conditioned by the degree of efficiency attained by an inborn mechanism. "Intelligence," says Maynard Ship-

ley,¹ "is measurable by the ability to make a rational adjustment of self to the environment; to understand the relationship between cause and effect; to recognise the difference between 'thobbing' and *thinking*; to appreciate the distinction between mere speculation and results based upon ascertained facts set in order. In its highest phase intelligence is the power of perceiving relationships between apparently disparate facts, formulating generalisations upon organised but seemingly discrete phenomena, and predicting verifiable but as yet unknown results from stated premises." In a word, intelligence is what has brought man upward from the beasts.

Doubtless intelligence tests as now constituted do not measure intelligence as thus conceived with a high degree of accuracy, but they have gone far enough in this direction to be significant. And they show, as did the work of Galton, that variability in mental capacity is quite on a par with variability in size or weight or any other physical characteristic. They show that races have average differences, levels of intelligence, as Goddard calls them, reaching as high as 10 per cent of the whole range. Still greater differences may be found when the lowest divisions of mankind are compared.

Little would be gained by concrete citations of the numerous researches of this type that are scattered throughout the literature. They must be compared with great caution, making due allowances for selection among the samples studied and for non-comparable features in the tests as given. One who makes a thorough study of the available evidence, however, cannot avoid concluding that the intelligence level of the negro is far below that of the white, though not significantly different from the lowest of the white subgroups. The range of averages in the white subgroups extends as far above the general average as that of the negro does below it. The negro thus far measured is

¹ *The Forum*, April, 1927, p. 604.

the American negro, no data for his African relations being available. Nor is much known of the yellow groups. The few investigations made on selected samples indicate levels and ranges very similar to those exhibited by the whites.

Two points more regarding intelligence tests. People unfamiliar with scientific methods often object to this type of examination on the ground that the direct measurements are on acquirements. In a sense this is true. One cannot measure intelligence except by observing its results after development. But this is no reason for assuming that the observations made cannot be interpreted in terms of native intelligence. Similar methods are used in physics for determining the laws of electrons, in chemistry for determining the behaviour of atoms and molecules, and in genetics for tracing the distribution of the genes. Is it not highly significant that the development of intelligence as determined by these methods practically stops at about 18 years, synchronously with growth, although the acquirement of knowledge continues throughout life? A second criticism is to the effect that these tests were made by white men of a particular civilisation, the inference being that the Hottentot could get up a series of intelligence tests in which he would be superior to the white. The premise is correct. The inference is wrong. Galton long ago pointed out that the native chief, a selected man, educated in the art of government, has often to make use of his wits in conference or rivalry with the ordinary white traveller who is in an unfamiliar environment. The traveller almost invariably holds his own. People of a different culture are undoubtedly handicapped when undergoing the current psychological examinations, but it is doubtful whether the handicap is significant. The similarity of results from tests of different types would seem to indicate that it is not. Moreover, effectiveness in our own culture, the dominant culture, is the real test of fitness to-day. We have to build railroads, to solve differential equations, and to devise adequate treatments of human

ills. Ability to track game in the forest primeval no longer has survival value.

A word in conclusion. There is a genetic basis for intelligence, as for any human characteristic, and races differ in their average levels. This fact has a significant bearing on national policy with respect to the education or the legal control of such wards as the American Indians and the Filipinos. Of more importance, however, is the genetic corollary. Some races do not display variability in intelligence ranging into the uppermost categories. Their likelihood of producing creative ability of the calibre necessary for the continued upward trend of civilisation is negligible. This is an item of knowledge to be pondered. Its import in matters like immigration, where amalgamation ensues, is eugenically serious.

Races also differ physically to a degree that makes the desirability of intercrossing questionable, though just what the genetic recommendation should be is not always clear. Mjøløen's generalisations on the so-called "disharmonies" of race crosses do not seem to be universally valid, yet perhaps they are sound in special cases. No geneticist would advise crossing dairy breeds and beef breeds of cattle with the view of improving either, because the hereditary differences are too numerous to make success probable; and certain human hybrids in Central and South America and in Africa seem to have met just such obstacles to racial development. On the other hand, desirable combinations of supposedly extreme types are not uncommon. Four of the thousand gifted children of California studied by Terman are the issue of a single Japanese-American marriage. The fitness of the individuals is evidently the chief matter to be considered.

The final point is the one to which we alluded when discussing *The Grammar of Heredity*. The degenerate product of a bad genetic combination is not saved by the record made by others of his race. Greatness is an individual matter. There are no uniformly great races. Historically the Jews

are great. They have wandered over the earth and have mingled their blood with the blood of other peoples. Contrary to the general belief, they form one of the most variable groups on earth, as Fishberg has shown. Starting as a mixed race, they have become more mixed. In every country they have produced exceptional individuals, and these exceptional individuals have usually married well, whether within or without the faith. Stringently selective breeding, therefore, has brought forth individuals celebrated in nearly every line of human endeavour. The world owes them much. Historically the Nordics are a great race, especially where there has been some intermixture with Alpine peoples. The world owes *them* much. They have left their mark on every science, on every art. *But it is not the race that counts, it is the individual.* The genetic basis of genius being what it is, the race producing exceptional segregates on one side of the curve must also produce exceptional segregates on the other side of the curve. The presence of genius entails the presence of simpletons in the ordinary course of human affairs. Under a strictly eugenic régime this would not be true; but it is true to-day, and probably will always be true. The simpletons of the world need not plume themselves on their racial connections, therefore; they cannot hide their qualities by braying about the worth of their relatives.

CHAPTER X

SOME SPECIFIC RACE PROBLEMS

THE concrete race problems confronted by the people of various countries are most difficult to treat, for race prejudice is an intense emotion which few persons have managed to subdue. Any one who feels that he has risen above unreasonable judgments of others should fill out the questionnaire prepared by Professor E. S. Bogardus,¹ of the University of Southern California, in which it is asked if there are peoples whom he would not admit to his country as transients or as citizens; to his occupation as subordinates, as fellow workers, or as superiors; to his street as neighbours; or to his home as social equals, with the possibility of intermarriage in the background. If he stops at any of these points in his consideration of a given race or nationality, let him state the reason, and let him ask himself if it is a just reason. He may wish to exclude all aliens in order to prevent a rapid increase in population pressure, or to exclude a given race of dissimilar customs as a means of promoting national solidarity. He may desire to avoid absorbing a certain race because of evidence indicating its general genetic inferiority to his own. Well and good! Rational arguments can be made on such grounds. But in the main one is likely to find that his reactions are emotional rather than rational—racial generalisations based upon dislikes so inarticulate as to appear almost instinctive.

Upon analysis, many of these prejudices become absurd. In part they are due to the habit of making careless statements which become axiomatic through repetition. The victim of commercial sharp practice at the hands of a Jew

¹ E. S. Bogardus, in *Jour. Applied Soc.*, March-April, 1925.

brands the whole race as Shylocks, forgetting that many of the most highly respected firms in the marts of trade are Jewish, and that the art of cozening is rather highly developed elsewhere. The unwilling caterer to the dietary needs of his gardener finds it easy to exclaim: "What can one expect with coloured help?" The material basis for many of our reactions is sound enough. We are wholly within our rights to dislike aggressiveness, boisterous conduct, boasting language, impoliteness, dirt, noisome odours. But why brand a people with these characteristics? Even when a given peculiarity is wide-spread in a certain group, is it reasonable to generalise? The Mexican peon of Arizona is usually dirty and smelly. Does this justify avoidance of one who is clean? For generations the Jew has had to be aggressive in order to survive. The Gentile dislikes the trait. Is the courteous Jew to become a victim of anti-Semitism while the aggressive Gentile is tolerated with equanimity?

I do not know how much intentional cruelty is represented in the treatment received by racial minorities, man being a rather merciless animal; but intentional or not, our actual practice is often cruel. Can one who has never been subjected to such usage understand the feelings of the cultured man or woman who is denied a seat in a Pullman car, a restaurant, a theatre, or a room in a college dormitory, for no other reason than the colour of the skin, the placement of the nyctaginic membrane, or the height of the nasal arch? My own belief is that these actions are not often malevolent. They are the gaucheries of a provincial people, on a par with the guffaws of a troop of yokels who see a well-dressed man for the first time. One cannot imagine a person who has had broad contacts with the world, a true cosmopolite, refusing to dine with cultured gentlemen from China or India, either because of differences in their physical traits or because of unfamiliarity with their mannerisms.

It is to be hoped that no one will read into these state-

ments a plea for doing away with all rules and regulations regarding social contacts. No such pleading is intended. I merely want to see our customs take on some degree of rationalism; I should like to have just treatment for all, in so far as this is possible. A passage in Washington's Farewell Address may be taken as the expression of a worthy ideal in the treatment of racial minorities, although the words were not used in this connection:

Nothing is more essential than that permanent, inveterate antipathies against particular nations, and passionate attachments for others, should be excluded, and that, in place of them, just and amicable feelings towards all should be cultivated. The nation which indulges towards another an habitual hatred, or an habitual fondness, is in some degree a slave.

Let no qualification but decent conduct entitle one to service in public carriers or within the establishments of "common victuallers." Let politeness requite politeness. Enroll students in our schools and universities on a basis of character and scholarship only. Have an educational and a property requirement for suffrage, if this seems desirable; but have these demands impartially ordered and executed. Make immigration restrictions severe, if necessary, but on scientific grounds. Consider racial amalgamation with eugenic standards only in mind. Have as many likes and dislikes as have a rational basis, but do not give way to prejudice. These might well be our maxims.

I realise, of course, that in expressing these views I have placed myself in No Man's Land, exposed to two fires. There are serious students, uncommitted to preconceived judgments, who will believe me to be a sentimentalist, ignorant of the practical difficulties involved in unprejudiced action. There are others who will call me a hypocrite because they will think that the views just expressed and those about to be expressed on the strictly genetic phases of race problems are not consistent. I do not believe that I am either a sentimentalist or a hypocrite, but I am quite willing to

agree that these are polygonal problems, many aspects of which are not clear.

Human stocks, like other stocks, can become relatively uniform through close breeding and selection. Intercrossing between two or more such stocks, if their genetic constitutions are different, increases variability. This is an advantage, provided each ethnical element entering the mixture has something valuable to contribute and later selection is not dysgenic. The rise of civilisation in Babylonia, in Egypt, in Crete, in Greece, in Rome, in northern Europe, and in the Italy of the Renaissance, followed close upon a period of intermixture between allied races. Even the eras of greatness in China and in India appear to have come shortly after the coalition of somewhat different races.

In view of these facts, it is sheer nonsense to attribute every defect of a mongrel stock to hybridisation. The laws of heredity support no such thesis. Deterioration is not a certain consequence of racial amalgamation, in spite of the opinion of Louis Agassiz. The slogan of Schulz,¹ "Nature suffers no mongrel to live," is not sound biology. The opinion of Madison Grant² that the hybrid stock resembles the lower of the component races is a mistaken genetic philosophy. Says Grant: "The cross between a white man and an Indian is an Indian, the cross between a white man and a negro is a negro, the cross between a white man and a Hindu is a Hindu, and the cross between any of the three European races and a Jew is a Jew." His statement is not in accord with the truth. The hybrids of the first generation are, on the average, intermediate between the parental stocks. The hybrids of later generations recombine their genetic differences in all possible combinations.

Yet numerous races have mingled their blood without seriously affecting the status of the arts and sciences. This result has been due in some measure to lack of opportunity;

¹ A. P. Schulz. *Race or Mongrel?* Boston, Page, 1908.

² Madison Grant. *The Passing of the Great Race*. New York, Scribners, 1916.

but aside from the significance to be attached to this important factor, it has a genetic basis which should not be minimised. The evidence is wholly in favour of the view that some stocks are undesirable grafts upon other stocks. In many cases where mixed-bloods have never risen, it is because genetically low extremes of both races have amalgamated. The Eurasian is a good example. The original Eurasians were the product of unions between a rather poor quality of Portuguese and an even poorer quality of Hindu. Where the English and Spanish have fused with selected individuals from among the Chinese, the Japanese, or even the Polynesians, the hybrid race is of decidedly better grade. The same observation may be made regarding the mongrel races of Mexico, Central and South America. The ancestors on both sides were a pretty poor lot. If the Mayas had amalgamated with Europeans of real ability, Mexico would probably have had a different history. Apart from these instances, however, there is abundant evidence that one component of certain mixed races had a generally low genetic value, and thus reduced rather than enhanced the desirability of the product.

It is only just to admit at once that many cases of racial antagonism have no biological warrant. The marriage habits of peoples have not been influenced by eugenic considerations. Intraracial caste distinction has nearly always been artificial. The European aristocracy is a royal creation based upon political expediency and favouritism; the bourgeoisie is divided according to income. Rare, indeed, is there a classification comparable to that of the Hindu, where the different orders betray their racial origin. Interracial antagonism, also, is often a matter of religion or of wealth. Witness the persecution of the Moors in Spain, or the friction between Jew and Gentile throughout the world. Nevertheless, beyond all this there is a residuum of race prejudice having a sound biological basis.

The best examples of undesirable race unions are found

among those from which a half-caste group emerges bearing definite marks of its origin, for they are the easiest to evaluate genetically. Moreover, it is under such conditions that racial jealousies reach their highest intensity. The offspring of other crosses, both intraracial and interracial, may be a deplorable lot; but if they are indistinguishable from the remaining members of the community, hybridisation goes quietly on without arousing much comment or opposition.

Race problems of the first type have become acute only since the beginning of the eighteenth century, when increased facilities for transportation promoted mass contacts between cultured and primitive peoples. To-day one finds half-caste races in nearly every country. Yet in spite of the wealth of laboratory material, very few careful, serious investigations have been made upon it. For information on many issues one is forced to rely wholly upon isolated observations of travellers, who are, on the whole, uncritical. Under the circumstances it seems best to confine the present discussion to the problem of continental United States, in which the American Indian and the negro are involved, interpolating only a few remarks on the racial situation in other countries in order to delimit the American race problem more definitely.

Several half-caste races have made places for themselves in territories undesired by the more cultured stock. The Eskimo-Danes¹ are fast supplanting the Eskimos in Greenland, and, according to most observers, they are superior to the Eskimos, though inferior to the Danes, both in physical vitality and in intellectual capacity. In view of these facts, the race-amalgamation policy of the Danish Government in Greenland may be reasonable. But one must compare the culture of Greenland with that of Iceland to get the true genetic perspective. The Hottentot-Boer hybrids, of whom we have more knowledge than of any other half-caste group,

¹ E. B. Reuter. *The Mulatto in the United States*. Boston, Badger, 1918.

due to the extensive investigations of Eugen Fischer,¹ are admirably fitted for primitive agriculture in South Africa. They are strong, healthy, reasonably industrious, and highly efficient at reproduction. But no one argues that they are superior even to the dull and stolid Dutch peasant who gave them one side of their ancestry.

There are offshoots of the primitive races which presumably would contribute no desirable traits to any of the higher groups, though there is little direct evidence one way or the other. The very backward negritoës of the East Indies and their lowly relatives of Central Africa could hardly be expected to raise the social level of the negroes if the groups were to amalgamate. The Ainu is a degenerate branch of the white race. The Japanese is not unreasonable to refuse to absorb him. The Indians of the Americas are poor relations of the Chinese and Japanese. Both the Mongolians and the Caucasians would do well to keep their family stocks clear of such scions. Fruit from similar graftings can be judged in Central and South America.

The hybridisation experiments of the Pacific Islands have hardly been studied sufficiently to make comment valuable. In the Philippines, where all races meet, there have been several attempts to investigate the physical proportion of persons of mixed blood, but, so far as I am aware, there has been no endeavour to evaluate their characteristics in terms of human efficiency and levels of intelligence. The impression persists that the few outstanding political and military leaders and those who are contributing their mites to the intellectual life of the Islands are, aside from a group of pure yellows and pure whites, persons of mixed blood—the alien ancestry being preponderantly Chinese and Spanish-Portuguese. But upon what factual basis this impression rests, I am unable to say.

Practically the same statement must be made for the Ter-

¹ Eugen Fischer. *Die Rehobother Bastards und das Bastardierungsproblem beim Menschen*. Jena, Fischer, 1913.

ritory of Hawaii at present, though there is hope, from the activity exhibited in anthropological circles,¹ that substantial progress in analysing the effects of race amalgamation will be made during the next decade or two. It is well known that the natives of Hawaii are among the most intelligent and progressive of the Polynesian group. They have met the efforts of America in a co-operative spirit, and the result is highly satisfactory. The effect of the eradication or control of the more serious tropical diseases, the result of the establishment of modern sanitary measures and sound government, is reflected in the growth of the population from 56,897 in 1872 to 255,912 in 1920. The foreign-born formed 34.1 per cent of the total in 1920, it is true; but nevertheless there has been a healthy natural growth. In 1920 the population was about half Chinese (9.2 per cent) and Japanese (42.7 per cent). The native Hawaiians formed 9.3 per cent of the total, with an additional 7.0 per cent of Caucasian-Hawaiians and Asiatic-Hawaiians. The Caucasians contributed 21.5 per cent, half of which was Portuguese. The Philippines were the source of the next largest group, 8.2 per cent. And in addition there was a scattering of Koreans, negroes, and others.

With this great opportunity for racial intermixture, the actual proportion of mixed marriages is not so great as one might expect, because of the tendency towards endogamy among the Japanese; but numerous intermixtures have occurred and are being studied carefully. Tozzer and Hooton, the distinguished anthropologists of Harvard University, are the leaders in the work. Thus far the investigations have been strictly physical, and have resulted in determining that the hybrids are generally intermediate in most of their measurable traits. There is no evidence of hybrid vigour as ex-

¹ See E. A. Hooton. "Observations and Queries as to the Effect of Race Mixture on Certain Physical Characteristics." Also L. C. Dunn. "Some Results of Race Mixture in Hawaii." Both in *Eugenics in Race and State*. Baltimore, Williams & Wilkins, 1923.

pressed in increased size, nor is there evidence of disharmonic combinations. A few characteristics, such as coarse, straight hair and the Mongolian fold, appear to behave as dominants. The psychological side has been neglected entirely.

As I have said once before, the geneticist dislikes to recommend union between extreme racial types on theoretical grounds—a position not determined by preconceptions of racial superiorities or inferiorities. But the only conclusion one is entitled to draw from the anthropological facts is that since the yellow and the white races have split into so many diverse subraces, the determining biological factor in the question of intermarriage is the genetic constitution of the contracting parties. On the other hand, there is evidence that the negro as a group and the American Indian as a group have little of genetic value to contribute to the higher white or yellow subraces.

The North American Indian is not a serious sociological problem.¹ The existing members of the group are not sufficiently numerous. It may surprise some readers, however, to learn that of the 270,000 people in continental United States who are classed as Indians, about half are of mixed blood. Prior to 1870 the white man and the Indian were continually at war, until the latter was driven into the various localities now set apart as reservations; yet these unsettled times did not prevent a great many unions between white men and Indian women. The French, in particular, had so little fixation on the subject of race that wherever they settled the pure-blooded Indian has been replaced by mixed-bloods. Arizona and New Mexico are now the only States where the Indians, some 50,000 of them, are full-bloods (over 98 per cent). In the remaining parts of the country substantially three-fifths of the Indian population is hybrid. And about four-fifths of the mixed-bloods is more than half white.

Physically the Indians of North America were rather a

¹ E. B. Reuter, *l. c.*

fine lot, though not such exceptional specimens as romancers would have us believe. The mixed-bloods, also, as Boas and others have shown, are well-developed animals, showing considerable vigour of hybridisation, and better able to withstand the diseases current among the white race than the pure Indian. In mental development the pure-blood shows his own peculiar qualities. The best of them have exhibited a capacity for leadership, a power of oratory, and a skill in simple common-sense logic which is not to be despised.

But the Indian has not accepted the white man's standard of civilisation. He has remained true to his primitive tastes. In spite of a fair degree of opportunity to obtain training in the arts and sciences, an opportunity accepted by several thousand individuals, he has produced no man of real note. The emergent Indian is simply the chieftain, and shows the shrewdness characteristic of the head man in all primitive tribes. Men having some Indian blood have appeared in the rank of the near-great, but none has reached the rank of the great. And the proportion of outstanding mixed-bloods is even lower than that found among the negroes having white blood.

One may assume, I believe, that the Indian will gradually disappear. He will be absorbed by the dominant white, without affecting the white race materially. The negro question is quite a different matter. There are 10,000,000 negroes in the United States.

In searching for pertinent facts concerning the genetic qualities of the negro, there are three lines of evidence to be considered: his physical qualities, his accomplishments in Africa and other parts of the world, and his achievements as a mixed-blood.

It is of no importance whether the negro or the white man is more closely related to the apes. The two are divergent groups. In the length of the arm, the degree to which the jaw projects, the form of the nose, and the shape, size, and thickness of the cranium, the negro stands closer to the

higher anthropoids than the white; in hair form and shape of lips he stands further removed.

Physically the negro seems to be a fit creature, and he necessarily was fit in his natural habitat; but in the United States his vitality as measured by the death-rate is low. Out of 16 causes of death studied by Wilcox,¹ he ranked lower than the white race only in cancer and tumour, diphtheria, diseases of the liver, and scarlet fever; and only for the last disease was the death-rate materially lower. In contrast, the tuberculosis death-rate was nearly three times and the pneumonia death-rate nearly twice that of the whites; and these two diseases caused 28.4 per cent of all deaths. Thus after due allowance is made for the difference in the sanitary conditions under which the two races exist in this country, there is little reason to believe that the negro is a better animal than the white when in a temperate environment.

The negro has a more acute vision than the white man, and perhaps a slightly better sense of hearing. According to Joyce,² the ethnologist of the British Museum, his sense of direction is extraordinary. In the sense of touch he rates rather low. His reaction time also is far from rapid.

Mentally the African negro is childlike, normally affable and cheerful, but subject to fits of fierce passion. As an agriculturist and craftsman he has made some progress under the influence of alien races, though his advancement is not comparable to that of his negroid relatives in the Philippines. His religion is a primitive fetishism combined with nature-worship. His whole history drives one to the conclusion that he is not a discoverer. In no case did he produce a written language.

The following estimate written by Joyce is certainly as favourable to the negro as the facts allow. Joyce says:

Mentally, the negro is inferior to the white. The remark of F. Manetta, made after a long study of the negro in America, may be taken as gen-

¹ W. F. Wilcox. In *Encyclopædia Britannica*. Ed. 13, vol. 19, pp. 346-349.

² T. A. Joyce. In *Encyclopædia Britannica*. Ed. 13, vol. 19, p. 344.

erally true of the whole race: "The negro children were sharp, intelligent, and full of vivacity, but on approaching the adult period, a gradual change set in. The intellect seemed to become clouded, animation giving place to a sort of lethargy, briskness yielding to indolence. We must necessarily suppose that the development of the negro and white proceeds on different lines. While with the latter the volume of the brain grows with the expansion of the brain-pan, in the former the growth of the brain is on the contrary arrested by the premature closing of the cranial sutures and lateral pressure of the frontal bone." This explanation is reasonable and even probable as a contributing cause; but evidence is lacking on the subject and the arrest or even deterioration in mental development is no doubt due to the fact that after puberty sexual matters take the first place in the negro's life and thoughts. At the same time, his environment has not been such as would tend to produce in him the restless energy which has led to the progress of the white race, and the easy conditions of tropical life and the fertility of the soil have reduced the struggle for existence to a minimum. But though the mental inferiority of the negro to the white or yellow races is a fact, it has often been exaggerated; the negro is largely a creature of his environment, and it is not fair to judge of his mental capacity by tests taken directly from the environment of the white man, as for instance tests in mental arithmetic; skill in reckoning is necessary to the white race, and it has cultivated this faculty; but it is not necessary to the negro.

Other judgments of the negro diverge in both directions from this view. Negrophiles maintain that the black man has done all that could have been expected of him in his environment, and tacitly assume that he could have gone ahead as far and as fast as he desired; negrophobes hold that he is just three jumps away from the gorilla. I believe that the truth is a little more unfavourable to the negro than Joyce admits. He errs in two particulars. The survival struggle is no less intense in the tropics than in other regions. In his native home the black man is subject to severe population pressure at a density of about ten per square mile—one-tenth of the average density possible to either the yellow or the white race. There is wealth to be torn from the soil, but a combination of bad climate and bad germ-plasm prevents the negro from obtaining it. The second point to be noted is with respect to the necessity for high intellec-

tual attainments among the whites as the mother of their inventive ability. It is difficult to see the force of such an argument as an apology for the status of the black race. Progressive races have created necessities, setting them continually higher through ability to attain them. If a stagnant existence with least effort is the ideal, then man is not the dominant animal. It is the cow.

The negro has not had an opportunity to work to his greater glory without interference under the stimulus of a temperate climate. But he has had his chances during the last century in the rich island of Haiti, with 200 years of French culture to give him a boost. Concerning the result, Reuter,¹ perhaps our foremost student of the negro problem, writes as follows:

The abandonment of the Island by the civilised powers so soon after the emancipation of the blacks was fatal to Haitian prosperity. The civil wars had destroyed property and capital of every description and left labour in a hopelessly demoralised state. The effect was as disastrous politically as it was economically: the political history of the hundred years is simply a narrative of revolutions. The country, nominally a republic, has in practice alternated between anarchy and military despotism. The actual power has been in the hands of the president who almost always rode into office as the momentary favourite of the major division of the army. Below the forms of civilised government there always has existed in every department of the official life every conceivable form of political corruption, official dishonesty, and judicial murder. "Justice is venal and the police brutal and inefficient." The Roman Catholic religion has degenerated into a thin disguise for the practice of the rites of Voodooism in which cannibalism and the sacrifice of children in the Serpent's honour has, at least at times, played an important part. The forms of marriage are disregarded or forgotten. Polygamy prevails in the interior and the frequent orgiastic dances are accompanied by promiscuous sexual debauchery. On the whole, the Island, during the century of independence and self-government, has made no progress along any line, has retrogressed in some lines and in others the "republic has gone back to the lowest type of African barbarism."

In Haiti the mulatto is in every way far in advance of

¹ *The Mulatto in the United States*, pp. 61, 62. Quoted by permission.

the negro. Of the 15 per cent of the Island's population who can read and write, nearly all are mixed-bloods. They control the republic, compose the professional classes, and own most of the property. Many of the wealthier youths are educated in Paris. Yet despite these advantages, they fail to lift Haiti above an essentially savage level. The Island has produced no creative work. Only one man of fair calibre has emerged from the mass, François Toussaint, who is said to have been a pure-blood, though this is doubtful. And Toussaint, called *L'Ouverture*, is much overrated. He showed the same type of crafty leadership so frequently found among savage chieftains, but no progressive statesmanship.

Turning now to the United States, what does one find? Here the negro has trebled his population in the seventy years between 1850 and 1920, reaching a figure at the latter date of 10,460,000. In the preceding decade, 1910-20, the increase was only 6.5 per cent, if the census figures are correct. Between 1900 and 1910 the increase was 11.2 per cent, and in every previous decade was still higher, reaching a maximum of 37.5 per cent in the first decade of the nineteenth century. The white increase during the same period was about 36 per cent in each decade until 1860. Since that time it has dropped at a rather definite rate, until in the decade 1910-20 it was only 16 per cent.

The negro birth-rate has fallen faster than the white birth-rate. No precise figures are available, but the trend can be estimated roughly by calculating for each race the number of children under five years of age per thousand women of child-bearing age. Between 1910 and 1920 the number of white children of this age-group increased by over 1,000,000, while the number of negro children of the same age interval decreased by over 100,000. At every census between 1850 and 1910, the number of negro children per thousand negro women of child-bearing age exceeded the same ratio for white women by from 40 to 170, but in 1920 the ratio of

children to white women exceeded the ratio of children to negro women by 42 per thousand. On the other hand, the death-rate of the negroes has not fallen at anything like the pace of the white death-rate. Here again exact calculation is impossible, but adjusted estimates of 28 per thousand for the negro and 18 per thousand for the white are not far from the truth. Thus the negro increase is diminishing rapidly, and what increase remains is coming in greater and greater proportions from the mixed-bloods, who in 1850 formed 11.2 per cent and in 1910 formed 20.9 per cent of the coloured population.

To put the matter baldly, the coloured population of the United States, forming about 9 per cent of the whole population, is rapidly changing from a fairly distinct negro group to a mixed-blood group, owing to the greater net fertility, stamina, and ability which the latter type exhibits. In these mixed-bloods, for whom we might as well accept the term mulatto, segregation and recombination of the traits of the two races is a continuous process. The result is a variable lot of individuals which at one end of the variation curve show no traces of negro blood. In fact, a considerable number of mulattoes now pass as white, and this number will increase materially in the future. We have gone a long way already towards the absorption of the negro germ-plasm, and this amalgamation will probably continue at an increasing rate. If the negro is the equal of the white, physically and mentally, or even if he contributes valuable qualities to the mixture, the process may be viewed with equanimity; if this is not the case, eugenic ideals will not come amiss in the future.

We have already seen that the negro is somewhat inferior to the white physically. How does he rate in mental ability? A random sample of the results of the army intelligence tests,¹ geographically representative, is as follows:

¹ R. M. Yerkes. Ed. "Psychological Examining in the United States Army." *Mem. Nat. Acad. Sci.*, vol. 15, 1921.

RACE	NUMBER OF CASES	PERCENTAGE MAKING GRADE						
		A	B	C +	C	C -	D	D -
WHITES Groups I, II, IV.....	93,973	4.1	8.0	15.0	25.0	23.8	17.1	7.0
NEGROES Group IV.....	18,891	0.1	0.6	2.0	5.7	12.9	29.7	49.0

This table gives a rough answer to the question, no matter what allowance is made for possible unfair application of the tests. Numerous other tests have yielded approximately the same results. Every observer has found that the negro ranks much lower than the white in all tests designed to evaluate the higher mental functions. In motor capacities and in such qualities as perception and discrimination, there is no appreciable difference between the races.

There is another test of intellectual capacity, however, which in some ways is better than the psychological examination. The contributors to progress are the individuals at the major extreme of the mental curve—the highest 1 per mille at most. Let us then examine the outstanding men of the negro race. Roughly 25,000,000 negroes, so called, have had an opportunity to express their qualifications in accomplishments since 1870. Of these, about 2,500,000 were mixed-bloods. Which type has been productive?

Such a test is important in a genetic evaluation of the negro for this reason. There are some rather eminent persons among the negro group. They have not reached the pinnacle called genius, perhaps, but they have done creative work of high merit. Sentimentalists have waxed maudlin over negro accomplishment in consequence. But the question is: Are these meritorious efforts really due to negro germ-plasm? We must remember that heredity in men is the result of the activity of 48 gene-packets. In a union between a negro and a white, each race supplies 24 of these gene-packets. And in all matings between such first gen-

eration hybrids, segregation and recombination occur. Even if no further white germ-plasm is added, therefore, any particular mixed-blood of a generation later than the first cross may have a preponderant number of white gene-packets. Since traits recombine more or less independently, a mixed-blood with a relatively dark skin and other physical characteristics of the negro may be essentially a white man. If he looks like a mixed-blood he is certain to carry white germ-plasm, but he may have a large percentage of white genes, even if he seems to be a rather pure negro.

A year or two ago Alain Locke edited a book entitled *The New Negro: An Interpretation*. It was a fine performance, despite some nonsense it contained about the value of primitive negro art. Mencken¹ speaks of it as a phenomenon of immense significance, representing the negro's final emancipation from the inferiority complex that has conditioned all his thinking and a determination to point with pride to his own merits. His review is a sincere and courteous approval of a tolerant, dispassionate, meritorious work. When Locke, Johnson, White, Fisher, Miller, and other contributors are compared with some of the present-day Southern writers, the contrast, he says, is pathetic. "The Africans are men of sense, learning, and good bearing; the Caucasians are simply romantic wind-jammers, full of sound and fury, signifying nothing."

I do not quarrel with the substance of this statement; but it is extraordinary that a man of Mencken's perspicacity, stared out of countenance, while he read, by the polychromic portraits of the contributors with which the volume is illustrated, should speak of them as Africans. No single one is indubitably a negro in the genetic sense. As one who has had a wide experience in making genetic judgments, I am forced to conclude that the developed germ-plasm causing the making of this book is nine-tenths white at least. The whole performance gives no evidence what-

¹ H. L. Mencken. *The American Mercury*, Feb., 1926, pp. 254, 255.

ever of negro capacity; it simply shows what the mixed-blood can do.

Reuter¹ has studied in detail the records of exceptional negroes. His list includes the names of all members of the group "who, because of education, opportunity, special talent, superior native ability, exceptional industry, or for other reason have made a noteworthy success in business, professional, artistic, or other lines of human endeavour, and so have become the exceptional and important men of the race." It is a negro Almanach de Gotha, a record of their intellectual, social, and economic aristocracy. So large a group, 4,267 in all, naturally contains many persons who would be negligible mediocrities in a white world, though there are about 200 who would merit honourable mention in any company. Reuter has classified them into full-blooded negroes and mulattoes, as far as possible along the line adopted by the Bureau of the Census. Unfortunately, this mode of segregation means little biologically because the individuals included in the mulatto class are all mulattoes, while the individuals included in the full-blood class are the dark-skinned persons of "three-fourths or more negro blood," many of whom must have a considerable proportion of white germ-plasm. Notwithstanding this error in favour of contributions from full-blooded negroes, there were 4,267 mulattoes and 447 negroes in the list. Thus some 25,000,000 negroes have produced, as a maximum, 447 persons of noticeable merit, while the 2,500,000 mulattoes have produced, as a minimum, 4,267 persons of like accomplishments.

When the selection is made more stringent, the value of the mulatto stands out in a more striking manner. Mr. Du Bois² published a *Who's Who in Colored America* in 1916. It contained the names of 139 individuals who were, in the opinion of the editor, the leading American negroes. No information was obtainable concerning three of the men thus

¹ *The Mulatto*, l. c.

² W. E. B. Du Bois. "The Crisis Calendar for 1916." Cited by Reuter.

listed. Of the remaining 136, 132 were clearly mulattoes. The group of four who were supposed to be pure-bloods contained an author of moderate merit, a school principal, a church bishop, and a public official.

A second list, compiled from the results of a questionnaire addressed to thirty-six prominent negroes, who were asked to name the 25 most eminent men of their race, contained 246 names. The ancestry of 3 could not be determined. Of the remainder, 227 are indubitably mulattoes, while 16 are either full-bloods or questionable.

The so-called "Advance Guard of the Race," the ten men believed by Mr. Du Bois to be men of mark, as measured by any fair standard of human accomplishment, includes only one man who is supposed to be a pure black. This man is Paul Laurence Dunbar, whose pathetic melodies can hardly be called great poetry.

Summing up, the negro as a social group has produced but one man who would be placed among the first 15,000 or 20,000 Great Ones of Earth, as judged by the usual standards. This is Alexandre Dumas, one of whose grandmothers was a negress of San Domingo, though whether a full-blood or not is unknown. In addition, there are perhaps twenty-five individuals who have produced intellectual or artistic work of which most of us might well be proud, but who would have to be placed in the fourth or fifth rank when considering true greatness objectively. And all of these people, so far as I can learn, are mixed-bloods, unless Dunbar is included. In literature there are several poets, critics, essayists, and short-story writers, but they have produced nothing not surpassed by hundreds of white writers during the same period. Countee Cullen and James Weldon Johnson are perhaps the most distinguished poets, and W. E. Du Bois the most eminent essayist and critic. Negro music, which is now in great vogue, is interesting but not great. Samuel Coleridge-Taylor is the only composer of real ability, though Roland Hayes is a highly capable performer.

In painting, sculpture, and architecture there is nothing. Dramatists are also lacking. Even on the stage, where the reputed ability of the negro as mimic might be expected to produce results, there has been no serious work. Bert Williams, a West India mulatto, is the only entertainer of note, though perhaps Rosamond Johnson, the pianist, and Anita Bush, the actress, should be added for good measure. There have been several worthy lawyers, physicians, educators, and divines, but few scientists and inventors. In fact, the higher the intellectual demands, the worse the showing. According to G. B. Halstead,¹ "no one with a drop of African blood has ever given us a theorem in mathematics."

The coloured race has not had an opportunity for advancement comparable to the white race. This must be admitted. But the opportunity of the mixed-blood has scarcely been greater than that of the pure-blood. The obvious conclusion from these facts and figures, therefore, is that the gene-packets of African origin are not valuable supplements to the gene-packets of European origin. It is the white germ-plasm that counts. And it counts in proportion to its percentage. This is further shown by the fact that first-generation hybrids have hardly ever had distinctive achievements to their credit. It is when recombination of the genes occurs, bearing with it the possibility of additional white endowments, that men of merit appear.

We can find no probability that the negro will contribute hereditary factors of value to the white race, yet the pure negro will gradually die out and the remaining members of our population will vary imperceptibly from black to white. In the social sense the black race will be absorbed. In the genetic sense the black germ-plasm will remain because the inheritance of genes is alternative. What are we going to do about it?

It seems to me that we must make the best of the situa-

¹ Quoted by T. D. A. Cockerell. "The Making of a Biologist." *Pop. Sci. Mon.*, 62: 512-520, 1903.

tion. The negro cannot be deported or sterilised. He must be treated decently, educated up to his intelligence level, and made a part of our political system where qualified. I can see no reasonable excuse for oppression and discrimination on a colour-line basis. I have no sympathy with a regimen of repression on the part of the whites, and no sympathy with the militant aggressiveness of such organisations as the Association for the Advancement of the Coloured People, which lobby and threaten, to gain the acceptance of ill-advised programmes. There is no reason for trying to make university men either of all negroes or of all whites. To give the ballot to morons and illiterates of either race is foolish. But it does seem to me that many of the unpleasant elements of the situation can be eliminated by approaching all matters from the individualistic rather than the racial point of view. I am inclined to believe that even the strictly genetic phases of the matter can be settled on this basis. It is a question of eugenics ideals. An aristocracy of brains is difficult to establish and still more difficult to maintain. There is too much variability everywhere. Each individual must stand on his own merits. Brilliant fathers beget stupid sons. The man of humble birth, though the son of average parents, may have received a happy combination of hereditary factors. Nevertheless, a high value must be placed upon good breeding, for every member of a good stock is much more likely to receive a likely lot of gene-packets than is every member of a poor stock. The Galtonian idea of race betterment through conscious selection as a sort of religious tenet is the only true conception of the race question.

Of course the negro-white muddle is not the only one which stands in need of clarification by adopting such a doctrine. The United States has received Europe's waste products as well as her best goods. For years England made the place a dumping-ground for her criminals and morons. Later it became the poor farm and penal colony of Italy.

In fact, nearly every European government planted its deportations here at one time or another, and the consequences can be traced in those various racial islands of undesirables along the Atlantic seaboard which have been studied in detail by the Eugenics Record Office. Responsible American manhood and womanhood had best keep their family lines clear of such types.

Fortunately, worthy people emigrated from these same countries, often despite the wishes of their governments. They have done well, thanks to the riches they found here and to their own innate ability. If they show a little more common sense about their mating customs in the future than they have in the past, there is a bright prospect that the United States will become a more outstanding leader in the world's civilisation than it is to-day. But retrogression is inevitable if they continue to accept and act on the ridiculous doctrine, which is already wide-spread, that the very air of the country makes its people great, whatever their natural endowments.

The chief source of the environmentalist dogma mentioned above is the work of Boas¹ on the differences in the average cephalic indices between the children of Hebrew and Sicilian New Yorkers and their foreign-born parents. It has become a Holy Writ for sociologists. From it they draw all sorts of unwarranted inferences as to the effect of the environment upon the growth and development of the individual, even going so far as to admit no value whatsoever to heredity. For some unknown reason, no genetic judgment of this investigation has appeared. I am glad, therefore, to be able to include in this chapter a criticism hitherto unpublished which has been prepared by Doctor Conway Zirkle.

The foreign-born Hebrews, a round-headed race with an

¹ Franz Boas. "Changes in Bodily Form of Descendants of Immigrants." *Sen. Doc.* 208. Washington, 1911, p. 573.

average cephalic index for adult males of 83.0, have appreciably longer-headed descendants, their average cephalic index being 81.4; while the adult descendants of Sicilians, a long-headed race with an average cephalic index of 77.7, have rounder heads, the average cephalic index being 81.5. Whatever the cause of this change in the cephalic indices of the American-born may be, it is not directly due to the environment, for Boas very clearly states (p. 60):

Among the Hebrews the cephalic index of the foreign-born is practically the same, no matter how old the individual at the time of immigration. This might be expected when the immigrants are adult or nearly mature; but it is of interest to note that even children who come here one year or a few years old develop the cephalic index characteristic of the foreign-born. . . . The conditions among the Sicilians and Neapolitans are quite similar to those observed among the Hebrews. The cephalic index of the foreign-born remains throughout on almost the same level.

The child is influenced only through the mother. Concerning this phase of the matter, Boas says (p. 57):

"The influence of American environment makes itself felt with increasing intensity, according to the time elapsed between the arrival of the mother and the birth of the child."

The idea is again emphasised as follows (p. 7):

It appears that the longer the parents have been here, the greater is the divergence of the descendants from the European type. The developments may be illustrated by a comparison of Hebrews and Sicilians. The approach of the Hebrew and Sicilian types becomes very clear when we divide the American-born descendants into those born less than ten years after the arrival of the mothers and those born ten years or more after the arrival of the mothers.

The change is thus greater in the children when the mothers have had longer opportunities for contact with races other than their own. Whenever two cross fertile races are in contact, some contamination is apt to occur, even under controlled conditions in a laboratory; and the New York women of the East Side are not grown in pint

milk-bottles. Boas, however, believes that this change is not due to racial crossing and summarises certain results as follows (p. 157):

The comparison between the correlations between fathers and foreign-born children and fathers and American-born children shows no loss in the correlation among the American-born. It is, however, somewhat striking that the correlation between parents and American-born children is very much more variable than the correlation between parents and foreign-born children, and it does not seem impossible that we may recognise in this variability the effect of a disturbing factor.

Since intercrossing usually increases variability, the disturbing factor is not necessarily mysterious.

The doctrine that the American environment causes certain changes to occur in the transplanted Europeans so that they grow to resemble the "Old American" Stock, regardless of their origin, has been greatly strengthened by another misunderstanding. The fact that the changes in the head-shapes of the Hebrews and Sicilians are in opposite directions, and towards each other, has led to the tacit assumption that they are both approaching an American average lying somewhere between them. As the cephalic index of the Hebrews changes from 83 to 81.4, it does vary towards the American, as it does towards the Sicilian. The change in the average index of the Sicilian from 77.7 to 81.5 is, however, *away* from the average of the Old American Stock, shown by Hrdlička¹ to be about 78. The trend *away* from the Old American is even more marked in the Neapolitan, whose cephalic index averages about 81 when he is foreign-born, and 82.7 when American-born. Using the racial terms crudely, it can be stated that the New York environment makes the South Italian *less* of an American and *more* of a Hebrew. This fact is further borne out by the statements of Boas concerning change in stature. He says (p. 56):

¹ Ales Hrdlička. *Old Americans*. Baltimore, Williams & Wilkins, 1925.

“The stature of the Sicilians born in America is less than that of the foreign-born. This loss is not so marked among the Neapolitans.”

This is in spite of the fact that the Old American type is one of the tallest in the world.

We are by no means limited to two truly genetic hypotheses to explain the physical difference between the American-born offspring and their foreign-born parents. In the stable village population of Europe, there is much inbreeding. This is particularly pronounced in the Ghettos scattered throughout Russia and in the small Mediterranean villages. Such inbreeding tends to accentuate racial peculiarities and reduce variability. However, when these stocks are transplanted to America and the natives of various Ghettos meet and mate, and the villagers from many Sicilian villages cross, the resulting hybrid vigour would tend to make the American-born generation differ markedly from its parents.

CHAPTER XI

GENIUS, MEDIOCRITY, AND EDUCATION

IF there is a second experience bringing the feeling of unutterable humbleness aroused by contemplating the stars on a desert night, it is in reflecting on the accomplishments of the millionth man, the thinker, he who with a little coterie of peers has led the rest of us out of the wilderness of ignorance. He seems such a tremendous figure, such a remote variant from the human mass. The range in mental equipment permitted by divergent heredities and environments appears so extraordinary when compared with the range of physical differences. It is a phenomenon in which the observed results are all out of proportion to the machinery involved, like those in a liquid when the boiling-point is reached. Truly the great man is a problem; but not an unfruitful problem.

As I have already remarked at various points during the course of these arguments, heredity and environment collaborate in producing man. Together they make him what he is, *mentally* as well as *physically*. Serious students do not deny the truth of this statement; yet there is a tendency, in view of the great stretch between variants at both ends of the mental scale, to believe that circumstances have an especial influence on the final result in this domain. Take a hypothetical case. If two infants with identical heredities, Bantu one-egg twins let us say, are separated at birth and brought up in Paris and in Swaziland respectively, each will develop the physical traits of the family stock. They will probably be indistinguishable. And few of us would be surprised to find them so, for we have had opportunities of watching somewhat similar experiments in the foreign quarters of our great cities. It is much more difficult to avoid believing that the negro developing in the

Parisian milieu will not exhibit a much higher intellectual capacity than his kraal-bred brother; yet the conclusion to which the psychologists are driving us, willy-nilly, is that the twins will be as much alike in these as in other traits. The Parisian and the South African will learn different groups of facts, just as they will exercise different muscles; but their mental qualities will be of the same order.

Cattell¹ once aptly remarked that environment has an "absolute veto" on mental development. So it has; but it has no more veto power and no more power to initiate measures when dealing with mental than when dealing with physical attributes. In both instances environment merely harnesses the force of heredity. Environment can control both the food intake and the psychological experience of the individual; yet the flesh and blood built by the one and the character of mind built by the other will be much alike under any set of conditions. If the infant Newton had been cast among Hottentots, he would have announced no laws of motion; but he would certainly have shown himself to be the outstanding thinker of his homeland in some way or other.

Spencer's conception of societal evolution as a natural process controlled by given physical and social conditions is only part of the truth. Heredity is a factor in moulding the conditions. We are indeed creatures of our Age, dependent in high degree upon social tradition. When each new discovery has been made, from those of Prometheus to those of Einstein, the level of society has been raised. In this rise, however, society as a whole has been an inert mass. It has gone up because various Archimedeans have been busy with their levers. If social tradition were wiped out, there can be no doubt but that we should revert to savagery; nevertheless, the millionth man would immediately set about building a new culture.

¹ J. M. Cattell. "A Statistical Study of Eminent Men." *Pop. Sci. Mon.*, 1903, pp. 359-377.

In 1903 Cattell wrote: "Carlyle had the same heredity and the same initial environment as his brothers; why should he write of heroes and become one, while they remained peasants?" He was justified in asking this question twenty-five years ago; he would not be justified to-day. Carlyle had the same parents, not the same heredity, as his brothers. The differences in their mental endowments may have been as great as the differences in the physical endowments which made Tom Thumb a dwarf and his brother a six-foot athlete.

Nearly all misconceptions concerning the rôle of heredity in human affairs are due to the failure to appreciate the units involved. Sociologists, who naturally regard the individual as the unit in their own work, persist in this conception when endeavouring to make genetic analyses. It cannot be too strongly urged that such an attitude prevents scientific advance. The chemist would not have gone far if he had insisted on describing only the colour, the solubility, the melting-point, or other behaviour of copper sulphate as a whole. John Dalton's atomic theory made chemistry a science. Similarly, a genetic analysis of man is possible only when he is visualised as the product of a mosaic of genes. When this is done, the situation becomes clear. Genius is due to an accumulation of plus genes, incapacity to an accumulation of minus genes, mediocrity to a mixture of both. The middle class, genetically speaking, will be the most unstable class, therefore; it will continually throw off segregates into each of the other groups. The genetic upper class and the genetic lower class will tend to become fixed in quality, though the two may have quite different survival coefficients.

It takes only 20 differences in essential genetic factors, inherited independently, to give the possibility of 1,000,000 recombinations, only 26 or 27 to give the possibility of 100,000,000 recombinations. If the Thinker requires 20 plus genes, and the Simpleton 20 minus genes, then the Average

Man may be supposed to have about 10 plus and 10 minus genes. If a family stock, by selective matings, gathers together a preponderant proportion of plus genes, its average worth will rise; conversely, if a family puts its efforts into accumulating minus genes, its social value will drop. But even the mediocrities may produce Thinkers—or Simpletons—if the constitutions of the fusing germ-cells are such as to bring together the required genetic complex. Thus there is no difficulty whatever in accounting for emergent individuals like Carlyle and Abraham Lincoln in otherwise undistinguished families.

The proportion of eminent persons in such families will be low because of great differences in quality among the parental germ-cells. On a percentage basis, selected high-grade families will often produce 10, 20, even 50 times as many notables as mediocre families. Yet the absolute number of geniuses appearing in families of the latter type will always be high because mediocrity is plentiful. In fact, Ellis, in selecting the 1,030 persons who formed the subject of his *Study of British Genius*,¹ found that they came almost altogether from the so-called middle class. That is to say, he ruled out those persons whose position in the world was obviously influenced by the accident of birth, and found that very few persons of pre-eminent ability were thus excluded. Nor did they come in great numbers from the other end of the social curve. Of the notables selected, only 9.2 per cent came from the ranks of the skilled labourers, who formed about 27 per cent of Britain's population, and only 2.5 per cent came from the ranks of the unskilled labourers, who formed about 47 per cent of the population.

In this connection some interesting facts have been discovered. There has been a marked progressive decline in the proportion of eminent men emerging from the labouring classes of England during the last 200 years. This ob-

¹ Havelock Ellis. *A Study of British Genius*. London, Hurst, 1904.

servation, first made by Havelock Ellis, and later confirmed by several other investigators, shows that the paradoxical triumph of democracy is a greater stratification of society. In earlier days, when scholastic privileges were niggardly distributed, the better germ-plasm segregating out of the lower economic levels had little opportunity to demonstrate its worth. It was repressed by circumstances and kept the status to which it was born. When popular education became more wide-spread, the situation changed. The exceptional children who appeared had a chance for fame and fortune which they promptly seized. They rose to eminence, married well, and their sweating fellows saw them no more. The lower orders of society being thus drained of the little fine blood they had, the result was a continual diminution in the proportion of famous persons produced, in spite of a constant economic and literate advance. What a stubborn set of facts for the ultrasocialist!

Doctor C. M. Cox,¹ in her recent compendium entitled *The Early Mental Traits of Three Hundred Geniuses*, says that "the outstanding studies with a biological bias" are those of Galton, Ribot, James, Woods, and Davenport; and I would add some 20 others, including Ellis and Pearson. In other words, nearly all those who have studied the problem of great men quantitatively have had a "biological bias" to their conclusions. Would it not be better to use the word "emphasis" in place of "bias," retaining the latter term for those essayists who ascribe everything to nurture without making an effort to evaluate the facts?

It is surprising what a great number of mathematical tests these investigators have devised for inquiring into the origin of genius, and how well they support Galton's conclusion that no man can attain eminence unless he possesses innate ability of a high order. It is still more surprising that the facts go far towards establishing the further conclusion

¹ C. M. Cox. *Genetic Studies of Genius II. The Early Mental Traits of Three Hundred Geniuses*. Stanford University Press, Stanford University, 1926.

that "few who possess these very high abilities can fail in achieving eminence." Ward,¹ the leading American sociologist of his day, criticised Galton severely for the second inference, and with some justification, since it is capable of misconstruction. Yet Ward's strictures were overharsh. As I understand Galton, all he meant to do was to emphasise the difficulty of keeping a good man down. And such a statement accords with historical records. The number of men who have pushed their way to distinction from a mire of adversity is very, very large. If Galton meant to deny a "veto" to environment, he was obviously in the wrong; and men of Galton's calibre do not make *obvious* mistakes.

We can all think of great families: the Herschels, distinguished in astronomy; the Bernouillis, eminent in mathematics; the De Candolles and the Darwins in biology; the Brontës in literature; the Bachs in music; the Balfours in statesmanship and science. But Galton and, in his turn, Woods² drew no broad conclusions from such gross evidence. It is not sufficient to point out the obvious ability of the Montmorencys and Condés in contrast to the manifest mediocrity of other aristocratic families who had a similar opportunity to demonstrate their worth. There are better ways of measuring resemblance and of estimating the force of heredity. Woods, for example, made a mathematical parent-offspring correlation calculation for 494 pairs, and found that it was 30.07 per cent for mental qualities and 29.83 per cent for moral qualities—only a slightly lower correlation than Pearson had found for physical characteristics. In fact, Woods, from a study of the eminent relatives of the men in the Hall of Fame, drew the conclusion that the latter "are from 500 to 1,000 times as much related to distinguished people as the ordinary mortal is." No environmental differences can account for such results.

¹ L. F. Ward. *Applied Sociology*. Boston, Ginn, 1906.

² F. A. Woods. *Mental and Moral Heredity in Royalty*. New York, Holt, 1906. *The Influence of Monarchs*. New York, Macmillan, 1913. "Heredity and the Hall of Fame." *Pop. Sci. Mon.*, 82: 445-452, 1913.

One of the most instructive investigations is that of Cattell¹ on the origin of American men of science. Other researches are more extensive, but no other investigator has used such an unbiassed method of selecting material, and few have drawn such reasonable conclusions. Some years ago Cattell obtained a list of the thousand leading scientific men of the United States arranged in order of merit by the votes of their peers. That is to say, a number of eminent zoölogists arranged the names of the more distinguished zoölogists in order of merit; and these individual judgments were combined systematically and objectively to form a single list ranking that number of men which the percentage of zoölogists to total number of scientists required. This method was followed for each science. A questionnaire was then sent to 1,154 scientists from the final list requesting information in regard to their families. A goodly percentage of men replied, 975 sending usable information. A few of the more significant conclusions which Cattell drew after an intensive analysis of the data are as follows:

Of 917 leading scientific men, 628 were the offspring of native-born parents, while 65 others had a native-born father or mother. The American-born parents were mainly of British descent, as were 137 fathers, and an equal number of mothers of the foreign-born. Germany contributed 77 fathers and 66 mothers; other nations contributed 51 fathers and 44 mothers.

Thus 12.6 per cent of these scientific leaders was foreign-born and a like proportion native-born of foreign parents; while 14.0 per cent of the general population was foreign-born, and 13.5 per cent was native-born of foreign parents. Great Britain contributed 1.2 per cent to the population and 3.4 per cent to the scientific men; Germany gave 2.7 per cent of her children to the population and 1.9 per cent to the

¹ J. M. Cattell. "Families of American Men of Science." *Pop. Sci. Mon.*, 86: 504-515, 1915.

scientific men; Russia gave 1.7 per cent to the population and 0.6 per cent to the scientific men; Italy gave 1.5 per cent to the population and 0.1 per cent to the scientific men. The foreign-born, therefore, appear to have furnished nearly as great a proportion of eminent scientists as they might be expected to furnish. If these figures were a fair statement of the case for recent immigration as against early immigration (native-born), the newcomers might be considered to have made the best showing, since they could not be supposed to have had the advantages enjoyed by the others. It must be remembered, however, that a considerable proportion of the foreign-born scientists were called to this country to assume professorships because of reputations already made in their native lands.

It was not easy to determine the racial stock of these men, yet 8 Jewish families were found among the 71.5 families listed as German, 5 Jewish families among the 6 families listed as Russian, and 1 Jewish family among the 660.5 native-American families. There were 2 Japanese families, but no negro or Indian families. Among the leading hundred scientists, 7 were Jewish, 6 of them having been invited here to fill scientific positions. This fact speaks well for the race as a whole, though it is difficult to account for the low percentage of native-born Jews.

The occupations of the fathers of 885 scientific men were determined. The professional men, who formed 3.0 per cent of the occupied white males in 1850, contributed 43.0 per cent; the agriculturists, who made up 44.1 per cent of the occupied males, contributed 21.2 per cent; while those engaged in trade and manufacture, who formed 34.1 per cent of the occupied males, contributed 35.7 per cent. Not a single scientific man was the son of a day-labourer or a domestic servant.

These last results are comparable with those obtained by European students. De Candolle in his *Histoire des Sciences et des Savants depuis deux Siècles*, published in 1873, states

that, of 100 foreign associates of the Paris Academy of Sciences, 41 were scions of the aristocratic group, 52 of the middle classes, and 7 of the working classes. Galton found that of 96 contemporary leading men of science, the labourers and peasants had furnished none. Odin, in his *Genèse des Grands Hommes*, issued in 1895, reports that of 623 leading Frenchmen of letters up to 1825, 25 per cent came from nobility, 30 per cent from among publicists, 23 per cent from the professional classes, 12 per cent from the bourgeoisie, and 10 per cent from the lower classes.

"We may conclude," says Cattell, "that more than one-half of our men of science come from the 1 per cent of the population most favourably situated to produce them. The son of a successful professional man is 50 times as likely to become a leading scientific man as a boy taken at random from the community. My data also show that a boy born in Massachusetts or Connecticut has been 50 times as likely to become a scientific man as a boy born along the southeastern seaboard from Georgia to Louisiana.

"These great differences may properly be attributed in part to natural capacity and in part to opportunity. When it is asked how far the result is due to each of these factors, the question is in a sense ambiguous. It is like asking whether the extension of a spiral spring is due to the spring or to the force applied. Some springs cannot be extended a foot by any force; no spring can be extended without force. The result depends on the relation between the constitution of the spring and the force applied. If the 174 babies born in Massachusetts and Connecticut who became leading scientific men had been exchanged with babies born in the South, it seems probable that few or none of them would have become scientific men."

I can follow Cattell thus far, though I should like to point out how probable it is that the Massachusetts babies brought up in the South would have distinguished themselves relative to the demands of the new environment instead of as scien-

tists. When he goes on to say that "the decreasing proportion of scientific men in Massachusetts and Connecticut, and the increasing proportion in the North Central States during recent years must be attributed to an altered environment, not to an altered racial stock," then I cannot wholly agree. The racial stock in New England has certainly altered during the past generation; and it is not at all difficult to show that it has altered for the worse.

I can agree without reservation, however, to the following more general statements:

The son of a scientific man may, on the average, have the inherited ability which would make him under equally favourable circumstances twice, or ten times, or a hundred times, as likely to do good scientific work as a boy taken at random from the community. The degree of advantage should be determined. It surely exists, and the children of scientific men should be numerous and well cared for. But we can do even more to increase the number of productive scientific men by proper selection from the whole community, and by giving opportunity to those who are fit.

The number capable of exhibiting genius is limited, but many of them are lost through lack of opportunity. It is our business, it should be our principal business, to improve our civilisation by giving opportunity to those who are fit, while at the same time investigating the conditions which will give us a better race.

Since no man can become truly great without the requisite genetic constitution, one may fairly say that heredity is the Hamlet of our drama. Environment may sometimes play the rôle of grave-digger, burying hopes and blasting careers; but in these democratic times the variations in environment are comparatively small within a given nation. I think most students are agreed on this score; but if there are some differences of opinion as to where the emphasis should be placed, one need not debate them. Two other questions of importance are before us. The first is; Do we desire genius? The second, as phrased by Miss Cox, is this: "Given equally high abilities, what conditions of nurture will accelerate the development of these abilities to the

point of highest achievement possible, and what conditions will retard it so that neither that point nor yet the minimum for eminence will be reached?"

To question the desirability of genius seems queer. Without genius, without the millionth man, the rest of us would be a horde of savages. Yet no other genetic question is so frequently propounded. Due to the influence of Lombroso, who endeavoured to establish a preconceived conviction that genius is akin to insanity by reporting only the facts which supported his thesis, and due also to our own inferiority complexes, the conception of genius as a mental abnormality is widely diffused. It is expressed thus by Havelock Ellis:¹

"The cry is often heard to-day from those who watch with disapproval the efforts made to discourage the reckless procreation of the degenerate and the unfit: 'You are stamping out the germs of genius!' It is widely held that genius is a kind of flower, unknown to the horticulturist, which only springs from diseased roots; make the plant healthily sound and your hope of blossoms is gone; you will see nothing but leaves."

Ellis has shown that this idea is a ridiculous perversion of the truth. A generation ago, Maudsley wrote, "There is hardly ever a man of genius who has not insanity or nervous disorder of some form in his family"; but he made no effort to support his dogmatic statement with concrete evidence. If such a pronouncement had in it an element of truth, one should expect to find insanity in one or both parents of many of the 1,030 great men selected by Ellis for his *Study of British Genius*. What are the facts? Insanity could be traced in less than 1 per cent of the parents of these distinguished sons of Britain.

Doubtless this statistical result falls below the truth because of the difficulty of obtaining the necessary data, as the author admits. Yet it is unlikely that many cases of

¹ Havelock Ellis. *Essays in War-Time*. Boston, Houghton, 1917.

insanity among the relatives of such outstanding characters would escape notice. And only five instances were recorded where either of the parents of a British man of genius actually died insane, these presumably being cases of ordinary senile dementia. The brief list includes the mothers of Bacon, of Turner, and of Tillotson, and the fathers of Lamb and of Archbishop Leighton. There were some doubtful cases, but even when they are included, the proportion of geniuses with an insane parent remains less than 2 per cent—only a negligibly higher proportion than is found in the general population.

Assured that men of genius do not come from a degenerate stock, Ellis goes further and inquires whether they themselves show indications of a neuropathic taint. As a distinguished neuropathologist, he is well qualified for such an investigation, and he makes it without prejudice. One by one he considers such case histories as Cæsar, Mahomet, Saint Paul, Richelieu, Newton, Flaubert, Dostoievsky, and others who have glibly been treated as epileptics or worse by enthusiastic alienists with a flair for publicity. In only one instance is there an indication of true epilepsy in a man of great ability—that of Dostoievsky. Nor could more than one or two men of genius properly be called insane. Being persons of immense intellectual force, passionately interested in carrying out great tasks requiring high tension and persistent concentration, they often evinced a kind of explosive hysteria, as if overwrought nerves were righting themselves. They sometimes verged on neurosis and perhaps occasionally stepped over the line; but this is the extent of their pathological indications. More serious reactions might have been expected, in view of the tasks performed.

We need have no fear of encouraging genius. How shall it be encouraged, aside from efforts to promote eugenic ideals? Seek the geniuses out early and accentuate their opportunities is the logical answer.

A year ago the possibility of selecting genius in the bud

would have been denied vehemently. To-day denials become less dogmatic, owing to the extraordinarily interesting and suggestive work of the members of the psychology department of Stanford University.

Miss Cox,¹ using Cattell's objectively determined list of the thousand most eminent men of history as a basis, selected 301 individuals as material for investigating juvenile promise. Each case was prepared carefully by a search of 1,500 biographical sources. From the data thus assembled, Intelligence Quotients were estimated by three qualified psychologists for 282 individuals, on the basis of their performance records as children. The distribution of the *I Q*'s was as follows: 13 persons were rated between 100 and 115, 68 persons between 120 and 135, 128 persons between 140 and 155, 54 persons between 160 and 175, and 9 persons between 180 and 200. In the highest category, it may be interesting to learn, were Schelling, Bentham, Macaulay, Pascal, Goethe, Grotius, Leibnitz, Mill, and Galton—a great showing for philosophy. The precise ranking of these men, however, is of no importance, as this depended too largely on whether the data required for a fairly accurate determination were available. The significant fact is that where the biographical data on the intellectual giants of history are sufficiently detailed to permit an intelligence rating based on youthful performance, that rating is high. Thus another old legend is destroyed. It has long been a popular idea that the creative genius is often stupid as a child. He is not stupid; he is not even mediocre; he is brilliant.

The case histories of these precocious children are among the most interesting human documents I have ever read. Voltaire learned to read in his fourth year. "I wrote verses from the cradle," he says. At 10 he was discussing important questions of the day with Ninon de Lenclos. Haller, always at the head of his class, knew the Greek testament

¹C. M. Cox, *l. c.*

from cover to cover at 10, and made Homer and Horace his favourites at 12. When D'Alembert was 10, his master said he could teach him no more. Humphry Davy was making witty rhymes at 5. Descartes was "the little philosopher" at 8. Mill taught himself the calculus at 11. At 10 Hugo was translating fables from the French to Latin, and illustrating them with his own drawings. At 14 he had written a tragedy in approved classical style. Mozart had composed two Minuets and an Allegro movement before he was 6. Bentham was writing Greek and Latin at 4, and had passed his examinations for Oxford at 10. Pascal, without having seen a book on geometry, had made demonstrations of most of the propositions considered in the first book of Euclid by the time he was 12.

Francis Galton wrote the following letter to his sister before his fifth birthday.¹ Terman's comment on the letter is: "The only misspelling is the date. The numbers 9 and 11 are bracketed because little Francis, evidently feeling that he had claimed too much, had scratched out one of the numbers with a knife and pasted some paper over the other!"

"MY DEAR ADELÉ,

"I am 4 years old and I can read any English book. I can say all the Latin Substantives and Adjectives and active verbs besides 52 lines of Latin poetry. I can cast up any sum in addition and can multiply by 2, 3, 4, 5, 6, 7, 8, (9), 10, (11).

"I can also say the pence table. I can read French a little and I know the clock.

FRANCIS GALTON

February 15, 1827."

The prodigious labours of Miss Cox and her associates have added another Ossa to the pile of evidence supporting the idea that a proper heredity is the prerequisite of greatness. Superior advantages do count. The average opportunity enjoyed by these young geniuses was apparently greater than the contemporary population of developing

¹ C. M. Cox, *l. c.* Quoted by permission.

youths could command. How many other names might have graced the list could their possessors have been given half a chance? Yet one is impressed less by the somewhat superior grade of training received by a portion of this galaxy than by the size of the group to which men like Lincoln, Bunyan, Carlyle, and Faraday belonged, where ability triumphed over adversity. And one is impelled to ask the environmentalist why the sisters and brothers of the favoured ones, who shared their advantages, so seldom shared their fame. Miss Cox notes these points and draws the further conclusion that equally intelligent children do not always achieve equal eminence because a certain persistence of effort is also necessary. Such a deduction is obviously sound. But, one may inquire, is not this dogged pursuit of a given end, which is so characteristic of the great, also an inherited trait?

On the genetic side such evidence is superfluous, however, in view of the dozens of statistical investigations showing the importance of heredity in man's accomplishments. The significant and original contribution which Miss Cox makes is this: "Youths who achieve eminence are distinguished in childhood by behaviour which indicates an unusually high Intelligence Quotient." In other words, they are "the gifted individuals whom intelligence tests may discover in childhood."

The converse of this proposition, as the author admits, is yet to be proved. We do not know how many of the children of to-day who show extraordinary *I Q's* will become accomplished artists, creative writers, notable statesmen, or productive scientists. *We do know that they will come from this class.* It would be a sensible thing, therefore, to give the bright boys and girls a little more individual liberty; to provide them with more sympathetic and better-trained teachers. But do we act in this obviously reasonable way? The slightest study of our educational system shows that we do not.

Our public schools, our colleges, and to a large extent our universities, are making strenuous efforts to stifle originality. Fresh, novel, independent creative thought is not wanted, especially from the brains of our youngsters. For the promotion of national solidarity and the greater glory of the established social order, they must all be poured into a common mould, stamped with orthodox views. Popenoe¹ characterises the system properly when he says inquiringly, Is not the public school "merely a Procrustean bed, of Pullman-berth dimensions, in which the abler children are bludgeoned into an inert and docile conformity with the performance of the mediocre, while the efforts of an uninspired teacher are largely devoted to goading the moron into a little more speed than he is built for"?

It is natural that our present educational scheme should cater to the requirements of the mediocre child. A vast mass of human material belongs to this group and it must be prepared for sound citizenship, which, I take it, is the acceptance of priestly views on religion, party views on politics, and press views on everything else. Whether any other quality of finished goods could be manufactured out of this type of raw stuff, I do not know. Probably not! But the success of such a programme requires schoolmasters of the same calibre, schoolmasters with an inordinate desire to circumvent, obstruct, suppress, and destroy all indications of exceptional mental processes; and this makes it a bad system.

As T. L. Kelley² has shown in his extraordinary essay, *The Influence of Nurture upon Native Differences*, the stupidest pupils show the greatest improvement because nine-tenths of the energy of the teacher is expended in shoving them up to the dead-line of mediocrity and keeping them there. The best pupils, on the other hand, are deliberately

¹ Paul Popenoe. "The Lockstep in the Schools." *Jour. Heredity*, 18: 63-65, 1927.

² T. L. Kelley. *The Influence of Nurture upon Native Differences*. New York, Macmillan, 1926.

dragged back so that they will not disturb the harmony of the class. As a result, they relax, become inattentive, and slight their overeasy tasks. Their natural tendency to work disappears. They become loafers. Could anything be worse?

I do not wish to malign the teaching profession. It contains some wonderful men and women, a much better lot than should be expected at the salaries they receive. Yet the average intellectual level is lower than it ought to be, and even the teachers with real ability and adequate training are caught in the system. The supposedly good schools are therefore almost as bad as the admittedly poor schools. I have seen a teacher in one of the best high schools of Boston take a positively sadistic delight in levelling her charges to her own *I Q*, which I charitably estimate at 95. The poor youngsters were bombarded with platitudes and ballasted with empty arguments. Much of the teaching was palpably false; but even this is of less importance than the fact that the thinkers of the class were bullied into a state where their brains might soon be expected to atrophy through disuse.

I am not drawing upon my imagination in making these statements. One of the notable conclusions of modern Educational Psychology is this. If, in a given group of children, a single aptitude is studied under conditions which permit each individual to progress as rapidly as possible, the ablest will improve the most. When a class takes up geography or history or algebra, for example, there will be a manifest difference between the performance of the various individuals at the start. Under proper guidance all will improve, but the gifted pupils will show by far the greatest improvement. Nature asserts herself. The students start out unlike; they end up more unlike.

Now, this differential development, which is to be expected because of the wide variation in natural endowments, is just what our public schools prevent. Doctor Kelley has demonstrated mathematically that pupils ordi-

narily become more and more alike as the effect of their schooling. This is the result, as Popenoe expresses it, "of the tremendous pressure that is brought to bear upon them—not merely by the schools, it must be said, but by the whole machinery of civilisation—to produce conformity, to squeeze them into a common mould."

Our educational system has often been described eulogistically as a mill into which one pours rough-husked grain and draws out nice clean flour of uniform whiteness. There is more odium than credit in the metaphor if those who repeat it so glibly only realised the fact. Fortunately, it is a little inapt. The system is more of a mill-pond where the sin of oddity is baptised away, and some unregenerate souls refuse to bleach. Heaven help the country were it otherwise!

It might be supposed that we are doing nothing for the exceptional child. This is not true. We are making strenuous efforts to do something for these variant minds—*but only for the minus variants*. This is the grim humour of the situation. In our institutions for the feeble-minded are 50,000 patients, one-fifth of the number who ought to be there. No one begrudges the money for these places. Our aments should have the care they require and any training designed to make them self-helpful. Such is our feverish urge to drag them up to our artificial scholastic standard, however, that years of effort are sometimes made to teach a single child to spell "I s-e-e a c-a-t." This erudition presumably costs about a thousand dollars a letter. Is it worth the price? In addition, there are between two and three million "backward" children in the country, the borderline cases which hold back the progress of the normal children. In increasing numbers they are being taken out of the usual classes and given special training. This is naturally a great gain in educational efficiency. The ironic part is that the reform is not designed primarily to help the normal child, but rather to hoist the backward child into line.

There is more madness than method in our procedure. What we ought to do is to spend our money on the able. Give the intelligent special training. No other educational scheme will pay such dividends in the end. Says Kelley:¹

When established social routines are forsworn, we find chess-playing and musical geniuses of ages eight and ten; and when we do, we immediately pity the poor distorted creatures and exercise our beneficent influence to round them out, and we succeed so well that these youthful geniuses are seldom heard of in later life. Only a few creep through the barrage, and a few others avoid it by being neglected waifs as children and shunned as peculiar as adolescents, so that it is only when full-blown that they are "discovered" as saviours of mankind. Why should we not have hundreds of such where we now have tens? We, the schoolmen of America, can have, if we open our eyes to the rare growth about us, and if we compose our hearts to the concept that "frequently in the small frames that pass in review before us are greater minds and larger visions than our own."

Roughly, 60 per cent of our child population have *I Q's* between 90 and 110. Very few of them could finish the curriculum of a first-class college with credit. On the one side of this great middle class is a group of 14 per cent, with *I Q's* of between 80 and 90, who can finish grammar-school and perhaps a year or two of high school, though usually with from one to four years of retardation; below them come about 5 per cent with *I Q's* of between 70 and 80, who usually drop out of school at the fifth or sixth grade; still further below, with *I Q's* of below 70, are 1 per cent of feeble-minded. On the other side of the curve there is a similar gradation upward, ending with 1 per cent who have *I Q's* at over 130.

This last group is the group which receives the least special attention, and it is the group which, in all probability, will furnish our leaders. Terman has shown that the children making up this group are normal physically; in fact, they grade somewhat higher than the average. They are

¹ T. L. Kelley. *The Influence of Nurture upon Native Differences*, l. c.

good healthy creatures with plenty of play spirit. Delinquency and antisocial behaviour are practically absent. Nor are they overdeveloped in some ways and underdeveloped in others. They seem equally capable of becoming artists, poets, scientists, financiers, statesmen, or what not. And they have sense. They can reason. From them the teacher can get rational replies to questions, original thoughts, something out of the ordinary—if he has sense enough himself not to be satisfied with parrot-like recitations. And we do nothing for them. We prefer to spend our money on the lack-wits and the ne'er-do-wells.

Perhaps my enthusiasm for these young souls exceeds reasonable bounds. The Stanford-Binet examination for determining *I Q's* is hardly designed for testing adult intelligence. For this reason one cannot measure the demonstrably constructive minds of the world on the same scale. Yet the work of Miss Cox standing alone makes a fair demonstration that if any outstanding creative geniuses emerge during the next generation, they will come from the high *I Q* children of to-day. And the Alpha tests of the army, which do measure adult intelligence in a fairly satisfactory way, furnish corroboratory evidence. The men who did things worth while had high ratings.

I should be in favour, therefore, of tearing down our bulwark of civilisation, the public school, to the last stone, and building it up again anew if this were really necessary to give our budding geniuses, if any, a chance to flower and bear fruit. But it isn't necessary. A little reorganisation here and there, perhaps! And more money; larger and larger budgets! What we need is teachers of vision rather than marble school-buildings, teachers who will help and not hinder!

After all, I am not sure but that the only service which can be rendered to our candidates for greatness is to find ways and means of picking out the probable winners early, and then to see that no millstones are tied around their

necks. La Place was professor of mathematics at 19, Legendre at 22. Gauss wrote his epoch-making *Disquisitiones Arithmeticæ* at 24. Davy, whom Dumas styled the greatest of all chemists, was one of the most famous lecturers in Europe at 23. His electrolytic dissociation of the alkalies, which probably may be called the foundation of modern chemistry, was produced at 29. Berzelius wrote his two-volume *Treatise on Animal Chemistry* at 27. Thomas Young gave to the world his undulatory theory of light at the same youthful age. Newton discovered the binomial theorem at 22 and the differential calculus at 23. In the same year he discovered the law of gravitation, though he could not verify it until he had Picard's determination of the earth's radius 20 years later. And so it goes. Genius flowers in the spring of life.

CHAPTER XII

THE LOWER LEVELS OF HUMANITY

No social worker is unacquainted with the dreary chronicles of those discreditable characters known as the Jukes, the Kallikaks, the Nams, and the Hill Folk. There are scores of such histories; but these are typical.

The first and most noted investigation of this sort is the memoir of Dugdale¹ on the Jukes. It stands to-day, at the end of half a century, as one of the best examples of inductive methodology applied to sociological research. The author obtained his facts at first hand, analysed his data admirably, and drew conclusions which were concrete, pertinent, and usually non-speculative.

The inception of the work is interesting. In July, 1874, the New York Prison Association deputed Mr. Dugdale to visit and report upon 13 of the county jails. The outcome of his tour of inspection was unimportant until one particular county was reached where he found 6 persons, incarcerated under 4 family names, who proved to be blood-relations. Further investigations showed that these 6 persons belonged to a more or less inbred stock which had lived in the same locality for generations, a stock exhibiting characteristics which had made the family name a generic term of reproach. And preliminary inquiry showed that this reaction of the community was not unjustified. Of 29 adult males, 17 were criminals; of 16 adult males who were relatives by marriage or by cohabitation, 5 were criminals. These facts, as Dugdale remarks, clearly opened up a large field of study; but at the time he "had no idea of its

¹ R. L. Dugdale. *The Jukes: a Study in Crime, Pauperism, Disease, and Heredity*. New York, Putnam, 1st ed., 1877. 3d ed., 1910. Quotations by permission.

extent, and still less of the unexpected results which a subsequent analysis disclosed."

The Juke stock was traced back to a descendant of the early Dutch settlers, called Max, who was born about 1730. This Max had a numerous progeny, and 2 of his sons married 2 of 6 sisters—or half-sisters. Dugdale was able to trace the descendants of 5 of these sisters throughout 5 generations. The sixth sister moved out of the county, and all records of her doings were lost. The number of individuals recorded included 540 persons of Juke blood and 169 persons related by marriage or cohabitation, many of whom may have been blood-relatives.

Out of 162 marriageable Juke women, 84, or 52.4 per cent, were known to be harlots. Of 535 children born, 335 were legitimate, 106 illegitimate, and 84 unknown. Thus, under the lowest computation, 23.5 per cent of all children were illegitimate. Over 20 per cent of the males and nearly 13 per cent of the females received outdoor relief, while 13 per cent of the males and 9.5 per cent of the females received almshouse relief. Taking both sexes together, the State furnished almshouse relief to six and three-quarters times as many persons of Juke blood, in proportion to their numbers, as it did to the remaining inhabitants. As to crime, there were 34 male offenders and 16 female offenders. These defendants were convicted of 66 crimes against property and 16 crimes against the person—many of them serious offences.

The records of this worthy family, then, show that a probable total of about 1,200 persons cost the State over a million and a quarter dollars during two and one-half centuries of their existence. Calculations based on the known facts show that 280 pauperised adults received \$50,000 in relief—an aggregate of 2,300 years of outdoor relief and 150 years of almshouse relief. There were 250 arrests and trials, 720 years of activity in thieving and other criminality, including murder. There were 50 prostitutes, 40 of whom were diseased. At least 440 people were contami-

nated. When the potential cost of the Jukes—the losses in productive labour and so on—are added to the actual costs, the sum reaches the above grand aggregate.

Dugdale drew five conclusions from his investigation. The first was so phrased that it would hardly need to be altered to-day, except to qualify the reference to the hereditary nature of disease. "Where the organisation is structurally modified," he says, "as in idiocy and insanity, or organically weak, as in many diseases, the heredity is the preponderating factor in determining the career; but it is, even then, capable of marked modification for better or worse by the character of the environment. In other words, capacity, physical and mental, is limited and determined mainly by heredity. This is probably because it is fixed during the period of antenatal organisation."

Nor would the modern geneticist object seriously to the second and third conclusion, beyond maintaining that heredity fixes within narrow limits the potentially high capacity which leads the individual to appreciate the desirability of some of the customs demanded by society and to govern himself accordingly.

"Where the conduct," Dugdale writes, "depends on the knowledge of moral obligation (excluding insanity and idiocy), the environment has more influence than the heredity, because the development of the moral attributes is mainly a postnatal and not an antenatal formation of cerebral cells. The use to which capacity shall be put is largely governed by the impersonal training or agency of environment, which is itself very variable.

"The tendency of heredity is to produce an environment which perpetuates that heredity: thus, the licentious parent makes an example which greatly aids in fixing habits of debauchery in the child. The correction is change of environment. For instance, where hereditary kleptomania exists, if the environment should be such as to become an exciting cause, the individual will be an incorrigible thief; but if, on

the contrary, he be protected from temptation, that individual may lead an honest life, with some chances in favour of the entailment stopping there."

Only the pedantic stickler for form would cavil at these statements. They put the case in a few well-chosen words. Unfortunately, Dugdale, like many another, was not content to fashion his coat from the cloth in hand. His final conclusions are to the effect that environment tends to produce habits, and these habits to become hereditary. Thus the control of crime and pauperism is made to depend, in final analysis, upon proper training extending over two or three generations.

In 1916 Doctor A. H. Estabrook¹ brought the history of the Jukes down to date. Nearly 40 years had passed, and there were 2,000 additional members of the clan. There would have been more, but the expressed fertility of the married females had diminished. In generation III the average number of children per fertile married woman was 7.6; in generation VI this average had dropped to 3.9. There were no one-child or two-child families in the earlier generations; there were 54 such families in a total of 154 families of the sixth generation. Even the Jukes had been limiting their families in accordance with the current fashion—a fact which is worth calling to the attention of sociologists who maintain the impossibility of getting families of low mentality to use methods of birth-control.

What of the results? Have the Jukes shown improvement? We shall see. The recorded percentage of illegitimacy was practically the same as in Dugdale's study, the total being 16.28 as against the earlier figure of 17.26. The frequency of harlotry also remained fairly stable at 51.2 per cent. The trend of pauperism could not be determined easily because records of outdoor relief were lacking. The almshouse relief and institutional care of children had risen

¹ A. H. Estabrook. *The Jukes in 1915*. Carnegie Institution of Washington, Pub. 240, 1916.

somewhat, since 409 out of a total of 1,943 persons had been patients; but perhaps more adequate benevolent institutions may account for the change. In crime there was a betterment. There were indeed 118 criminals of Juke blood, but the family was no longer marked by the viciousness which led to Dugdale's original study. All in all, there were 654 persons whom Estabrook was able to classify on a rough social-adequacy scale. Of these, 76 were prosperous good citizens with mental and moral stamina, 255 were semi-skilled or unskilled labourers, and 323 were typical anti-social people of the kind described in the earlier investigation. On the whole, then, the Jukes have shown a slight but continuous improvement in social value. Why?

The reason for the performance record of this family is perfectly clear. The ancestral breeding-cage of the group was situated in a rugged, woody region margining a chain of five lakes surrounded by steep cliffs. Here, in this isolated place, the Jukes became squatters on the small plots of soil found between the clefts in the rocks; and here they remained, living in log or stone hovels, where all ages and sexes, relatives and strangers, bunked indiscriminately. Naturally, intense inbreeding followed. The germ-plasm was tainted. A goodly proportion of the individuals carried genes for mental deficiency. Consanguineous matings offered opportunities for the production of weak-minded offspring, and they appeared in quantity. The environment did the rest. The best of the clan, those with sufficient mentality to have risen above the general level of Juke standards, had little incentive to do much better, for man is essentially an imitative animal. The leaders among the Jukes found it sufficient to be—leaders among the Jukes.

In later generations the clan was less isolated. Inbreeding was not so conspicuous. As a result, fewer defectives were segregated out, and a slight but measurable improvement set in.

Proof of these statements is to be found in the work of

Estabrook. In generation III, 23 per cent of the marriages were consanguineous; in generation IV, 20 per cent; in generation V, 12 per cent; in generation VI, 5 per cent. If these are the marriage statistics, what is the true proportion of highly consanguineous matings among people living promiscuously as did the Jukes, with no restraint and no taboos? It must have been considerably higher than the records appear to show. Moreover, Estabrook found that in the sixth and seventh generations, after the clan had begun to break out of its ancestral habitat, the members still tended to marry like-to-like. Defective Jukes gravitated towards defectives of other families. Some individuals, however—the better-grade segregates—did marry into less degenerate families; and here one can trace improvement. Yet, on the whole, because of the proportion of selective matings, “the later descendants of the Jukes, in Connecticut, in New Jersey, even in Minnesota, still show the same feeble-mindedness, indolence, licentiousness, and dishonesty, even when not handicapped by the associations of their bad family name and despite the fact of being surrounded by better social conditions.” One must look with thorough disfavour, therefore, upon the efforts of organised charity to send such bad germ-plasm to other communities with the kindly intention of giving it a better environment. It is, says Davenport, “like scattering firebrands—each tends to start a fire in a new place.”

Of the 1,258 individuals living in 1915, who were descended from the 5 original Juke sisters, 698 are known to have attended school. Of this group, 55 showed no retardation, 249 did fair work, while 394 were retarded three or more years, and were unable to profit by the school training. They remained a steady braking power on the whole school system. Estabrook found only 107 Jukes to be so deficient mentally as to need custodial care; but all told he believes that about 600, or 40 per cent of the 2,094 total, were mental defectives.

I have discussed this family in some detail because, in spite of a wide-spread superficial knowledge of Dugdale's investigations, there seems to be no general appreciation of the fact that the Juke history is a history of mental defect. There was, it must be admitted, a bad environment; but this environment was genetically bad, the type which leads to inbreeding, and thence to an opportunity for the segregation of defectives, rather than bad in the sociological sense. As Estabrook remarks, "one rarely gets a bad environment where the parents are healthy and intelligent." Man makes his own environment.

Moreover, the chronicle of the Jukes is typical of other racial islands, of other isolated communities, where a given stock has become notorious.

The Hill Folk, studied by Danielson and Davenport,¹ are good examples. Two clans living in a fertile region, about half of them mentally deficient, have furnished about one-third of the business of the district court, and have received a large proportion of the pauper relief necessary in the community.

The history of the Nam family, investigated by Estabrook and Davenport,² is similar. Of 233 fertile matings, 23 per cent were consanguineous. Over 20 per cent of the children were born out of wedlock. Among the 1,795 individuals considered, 19 were epileptics, 24 were insane, 18 were in benevolent institutions, and 40 were in prison. The evidence indicates feeble-mindedness of various grades in about half of the individuals recorded.

In this instance one has the opportunity of comparing similar germ-plasm under different environments. Eight members of the group were adopted into good homes, or brought up under State care. Two of the eight appear to have done a little better than they probably would have

¹ F. H. Danielson and C. B. Davenport. *The Hill Folk*. Eugenics Record Office, Mem. I, 1912.

² A. H. Estabrook and C. B. Davenport. *The Nam Family*. Eugenics Record Office, Mem. II, 1912.

done if they had grown up in Nam Hollow, but the difference is discouragingly slight. The other six showed no improvement. Immediately after the Civil War, several Nams migrated to Minnesota. Six of these families have been studied by Miss S. C. Devitt, Field Worker of the State School for the Feeble-Minded at Faribault, Minnesota. Two families, though below the average in efficiency, are respected citizens. The others are low grade. Writing of them, a Minnesota physician who knew the facts says: "People sneer at them and they perhaps represent the poorest part of the population."

Again, there is the "Tribe of Ishmael," whose deplorable story was uncovered by McCulloch.¹ Three sons of John Ishmael married three sisters from a pauper family named Smith, and made Marion County, Indiana, their home. Nomads and paupers, they were thrown together, mating largely with their own kind. We have the record of 1,750 individuals. It is a story of defective germ-plasm—feeble-mindedness, wandering mania, and moral imbecility.

In 1898 a feeble-minded girl, Deborah, came to the Training School at Vineland, New Jersey. Her case interested Doctor Goddard,² the director of the school, and he set out to discover the family history. The immediate relatives of the child were found living in a populous farming district within a short distance from what was afterwards learned to be the ancestral home. There it was discovered that the family had been notorious for the number of defectives and delinquents during six generations. It was decided, therefore, to make a complete survey of the clan and to obtain the history, in so far as this was possible, of every person in it. The results are interesting. Wherever the field workers went, country, city, or mountainous district, families of two types were found; the one exhibited

¹ O. C. McCulloch. "The Tribe of Ishmael a Study in Social Degradation." *Proc. 15th Nat. Con. Char. and Correction*. Buffalo, 1888.

² H. H. Goddard. *The Kallikak Family*. New York, Macmillan, 1912.

an appalling amount of defectiveness, the other was normal, intelligent, and prosperous. Then came the clew to this apparent paradox. The great-great-great-grandfather of Deborah was Martin Kallikak, Sr.; the paternal ancestor of the good families in the fifth generation was this same Martin Kallikak, Sr. Old Martin had married, and from the seven children who were the issue of this marriage came a multitude of descendants who were valuable citizens. Before his marriage, however, Martin had a son by a feeble-minded girl whom he met at one of the taverns frequented by the Revolutionary soldiers. This boy, Martin Kallikak, Jr., afterwards known as the "Old Horror," married one Rhoda Zabeth, and by her had ten children. These individuals established a nest in which they remained more or less biologically isolated for several generations. When they married outside the group, their mates were of like calibre. From them have come 470 descendants. The investigators at the Vineland school were able to determine the mentality of 189 from among this group: 143 were conclusively proved to be feeble-minded, 46 were found to be normal.

A German family has been described by Poellman.¹ He uncovered 709 case histories belonging to six generations. Among them were 107 born out of wedlock, 64 inmates of almshouses, 162 professional beggars, 164 prostitutes, and 76 criminals. It has cost the State a million and a half dollars to date, and the costs are mounting.

The Zero family, a Swiss product, has been investigated by Jörger.² Its course is known more or less accurately for over 200 years, and is remarkable in two respects. In the late seventeenth century it divided into three lines. Two of these are respectable, one is degenerate. The progenitor of the defective line was a man who was himself the result

¹ See W. E. Kellicott. *The Social Direction of Human Evolution*. New York, Appleton, 1915.

² J. Jörger. "Die Familie Zero." *Arch. für Rassen- und Gesellschaftsbiologie*, 2: 494-559, 1905.

of a mating between Swiss and Italian degenerates. His immediate family consisted of 7 children. In 1905 the records of 190 of their descendants were obtained. Their outstanding characteristics were feeble-mindedness and the results of feeble-mindedness—vagabondage, drunkenness, prostitution, and criminality. The second matter of sociological importance in connection with this family is that in 1861 a godly and well-intentioned priest placed several of these children in good homes, in spite of the fact that one of the specialities of the clan was plundering Catholic churches and chapels. But his good intentions availed nothing. Sooner or later each child ran away and reverted to his old habits.

One might continue to describe such families; but these will suffice as samples. Considering them together, what conclusion can be drawn? Simply this: Every tenth or at least every fifteenth normal person carries mental defectiveness in half of his or her germ-cells, available for the production of an ament whenever chance brings an egg and a sperm of like quality together; and consanguineous matings increase the opportunity. Isolated, inbred communities may be good or bad; it all depends upon the quality of the germ-plasm. But when they are bad, like the character of the little girl in the nursery rhyme, they are very bad indeed. Not all degenerates are alike. The Jukes were notorious for their criminality, the Kallikaks for their imbecility, the Ishmaelites for their pauperism. The Zeros were vagrants, the Poellman family were prostitutes and procurers, the Nams were idle drunkards. No doubt the particular antisocial tendency exhibited is partly due to environment. It may also be due, in part, to the influence of minor hereditary factors. Whatever the cause of the variation in the manner in which defectiveness manifests itself, however, one should not lose sight of the important fact that the main difference between these representatives of the lower levels of humanity and those who are more fortunate is

innate lack of intelligence. There is the idiot and imbecile group, comprising those who cannot learn to take care of themselves properly. These every one recognises. But above this relatively small group, there is a larger group of people, perhaps 25 or 30 per cent of the population, who can learn the most elementary principles of the three R's, and can go no farther. Is it likely that the members of this great army, who cannot learn to multiply and divide, who cannot understand fractions, who do not appreciate the simple fallacies in such sentences as "The girl whose dismembered body was found is thought to have committed suicide," can distinguish between the desirable and undesirable in sex customs, can restrain such elementary passions as anger, or can make fine distinctions in property rights? Of course they cannot do these things. Their outlook on life is limited; their responsibility is imperfect. Yet when any one suggests that the most deficient of these creatures should be sterilised, and that the final hope of humanity is selective breeding, he is ridiculed.

Mr. Clarence Darrow¹ has recently been exercising his well-known skill in forensic combat by writing against eugenics. Any effort to increase man's innate strength in physical and mental attributes by selective breeding would be, he says, a dangerous "tinkering with the human germ-plasm." Wiggam comments that Darrow brings a little gaiety into the drab life of the biologist by speculating about what "heredity in man would be if it were something different from what biologists know very well that it is." I am afraid that the remark is true. It were perhaps better for the biologist's soul if it were not true. He has been content to smile at Mr. Darrow's extraordinary ignorance of things biological, and the errors to which this lack of preparedness has led him. He has chuckled at the grim irony in the great criminal lawyer's preference for the thieves and murderers

¹ Clarence Darrow. "The Edwardses and the Jukes." *Amer. Mercury*, 6: 147-157, 1925. "The Eugenics Cult." *Amer. Mercury*, 8: 129-137, 1926.

of the Juke family as neighbours over the scholars and diplomats of the Edwards family. When he has been less humorously inclined, he has wondered why the man who thundered so resonantly about Mr. Bryan's inability to appreciate the circumstantial evidence which led to the theory of organic evolution should himself be unable to see that eugenic tenets are strict corollaries of that theory, besides having numerous direct experimental proofs which the older theory lacks. He has been surprised that Mr. Darrow did not realise to what extent every civilised custom has tended to negate natural selection, to what extent it has been a tinkering with the germ-plasm which necessitates additional eugenic tinkering as a counter-force. He has also been somewhat saddened to see tactics of the courtroom counsel used in the discussion of a scientific question—the mention of a distinguished specialist on the subject as “a Mr. Davenport,” the endeavour to make the reader believe that the men whose views are attacked were ignorant of facts which had in reality been gleaned from their writings, the omission of unfavourable evidence. It seemed inconceivable that legal training should so far confuse the mind of such a worldly-wise barrister as to make him forget that the scientist does not plead a case, but seeks the truth, unimpeded by precedents and rules of evidence. These reactions, I am inclined to believe, are wrong. Mr. Darrow is subjective and emotional on matters concerning the conscious direction of human evolution; but he should be taken seriously, both because his attitude is similar to that of many other people who have no first-hand acquaintance with the facts, and because a sound conclusion is hidden in the midst of the nonsense.

There are at least 20,000,000 people in the United States—and a similar proportion in other countries—whose nervous systems are too defective for them to appreciate what is demanded of them in modern society. This goodly quota of irresponsibles are such because of their heredity. Their

children will tend to be like them. And I do not see that anything satisfactory biologically can be done about it. Though there is error in the premises and confusion in the logic of nearly every statement Mr. Darrow ever made on eugenics, with the instinct of a good lawyer he has sensed correctly that most of the eugenic proposals regarding these people bring us exactly nowhere. My admission is not to be taken as denying the desirability or the practicability of the consciously selective marriage customs proposed by Francis Galton. Such recommendations have a positive value which is not debatable. I refer solely to the various schemes for cutting off defective germ-plasm. It is possible, the Supreme Court has just decided that it is proper, to sterilise idiots and imbeciles. "Three generations of idiots are enough," one of the justices is reported to have said. Good! Suppose reasonable sterilisation laws were enacted in every State, and fearlessly enforced. The effect would be excellent. About 1,000,000 ill-conditioned people who can never be taught even the rudiments of personal hygiene would be prevented from begetting others like themselves. But even the most ruthless Platonist would hardly go so far as to recommend sterilising our 19,000,000 defectives of higher grade. And even if this were done, a new army with similar mentalities would be produced in each generation by normals who carry defective germ-plasm. It seems to me, therefore, one must conclude with Mr. Darrow, though not for the reasons which he gives, that the best-laid plans for cutting off defective germ-plasm are rather inefficient. The country will always be handicapped by the presence of some 20 per cent of defectives who will be the active agents in a great proportion of the antisocial acts committed. If their activities are to be restricted in any way, other than eugenic means must also be sought.

Statistically speaking, the units of our social organism are ranged along a broadly spreading curve running from idiocy to genius of the first order. There is no great gulf

fixed between responsibility and irresponsibility. Each of us has his life cycle determined by his heredity and his experience. Thus in every case the whole social organism must, in certain respects, be held accountable for the activities of its constituent parts, since germ-plasm and milieu react upon and influence each other. With a given distribution of germ-plasm, however, educational and economic systems determine the social trend. We are influenced by all advances which conserve and preserve the health—gymnasia, health centres, public clinics, hospitals, sanatoria. We are affected by the type of education given in the public schools and colleges, by the drama, the motion-picture, the printed page—particularly the printed page. But it seems to me that there is a justifiable distinction to be drawn between the debts which those who belong to the higher genetic levels and those who belong to the lower genetic levels of humanity owe to society and to each other. To make fine discriminations is impossible, just as it is impossible to say when the child becomes the adult; but the analogy is rather apt. The defective, whether he be an idiot or a high-grade moron, whether he be definitely insane or merely neurotic, is, in a sense, a child. He may vary in his appreciation of the amenities of life from what might be expected of an infant to what might be expected at maturity. The point is to appreciate the magnitude of this variation in judging conduct.

The simile cannot be carried very far, unfortunately; for the child grows up, the defective remains stunted and abnormal. There is also a more serious deficiency in the comparison. The defective tends to mate with defective and to produce more defectives; while in addition the normals who carry defectiveness in a fraction of their germ-cells contribute their quota to swell the current. The defective, therefore, is more like a cancerous growth parasitic on the healthy tissues of society—a cancer being a sort of juvenile tissue wildly reproducing itself.

Whatever can be done justly and reasonably to reduce this tumorous growth will aid the social health. Something can be accomplished in extirpating plague spots like those where the Nams, the Jukes, and the Kallikaks developed. Segregation in benevolent institutions or sterilisation is the only remedy in the worst cases. Perhaps this is the only remedy of a surgical nature; though I am sanguine enough to believe that if the more responsible members of society demanded it, made it one of the *mores* as a prophylactic social measure, many of the higher-grade defectives such as the morons, the neurotics, and the intermittently insane could be led rather docilely to see the desirability of cutting down the natural increase in their particular portion of the population.

Be this as it may, we probably will all agree that surgical measures are not a panacea. There remains the possibility of transforming this malignant growth to one which is more benign. The most desirable and most practical method of accomplishing this metamorphosis cannot be devised on the spur of the moment; yet one can visualise it somewhat as follows. If we really had a reasonably Utopian society where all persons mentally qualified to form rational judgments were bent upon contributing to the success of the social organism, every human being would have his history recorded, not as a police measure, but as an aid in social development. Richard Roe now has his birth, his marriage, and his death registered. He is given a certain amount of education, willy-nilly. When he contracts an infectious disease, it is reported. But this is not enough. Society should bear the burden of making the best unit possible out of Richard Roe. He should have medical examinations periodically throughout his life. His parents should be enabled to give him the proper food, especially when young. He should be immunised to smallpox, diphtheria, scarlet fever, typhoid, and so on through the whole gamut of serotherapy. His teeth should be attended to, adenoids and

other undesirable growths removed. From the cradle to the grave he should be made as efficient an organism as medical science permits. And this still is not enough. At the proper time let the psychologist and psychiatrist take him in hand. If he is normal or supernormal, enable him to develop to the limit of his capacity; if he is subnormal, guide him. Here, I think, is the nearest we can get to a solution of the problem of the subnormal. If the defective is discovered early and cared for properly, he may become a relatively useful member of society.

The present generation will not see such a vision materialise. Preventive measures are never adopted until long after curative policies of the same type have become familiar, as every one acquainted with medical history knows. Intelligent treatment of the lower levels of humanity will come first in penology.

Extraordinary progress has been made in theoretical criminology during the past century. The practical application of advanced knowledge has followed slowly, as is always the case; but the forward movement is measurable. Society has passed the witchcraft stage; it is reluctantly relinquishing the doctrine of *lex talionis*, an "eye for an eye and a tooth for a tooth"; yet it is still swayed more by the concepts of outworn dogma than by those of scientific research. Our attitude towards the criminal is revengeful rather than curative, that of the angry God rather than the physician. When Havelock Ellis wrote *The Criminal* in 1890, he said: "Our courts of justice are still pervaded by the barbaric notion of the duel. We arrange a brilliant tournament, and are interested not so much in the investigation of truth as in the question of who will win." The remark is as pertinent to-day as it was then.

At the same time, no one familiar with the literature of modern criminology can fail to be impressed by the sincere endeavours which penologists are making to uncover the truth and to devise remedies. They are miserably slow in

ridding their minds of the bogies conjured up in the days of superstition, but one cannot expect social changes to take place rapidly. Last year C. L. King edited a volume of the Annals of the American Academy of Political and Social Science entitled *Modern Crime: Its Prevention and Punishment*. There were 12 articles on Modern Tendencies in Crime, 10 articles on Judicial Procedure and Modern Crime, 15 articles on Prevention of Modern Crime, and 6 articles on Punishment of Modern Crime as a Means of Crime Prevention. These essays were written by our most distinguished penologists. They contained many pertinent data and many illuminating suggestions. There was hardly a writer unconvinced of the futility and failure of punishment for crime. They seemed to agree that the criminal gets his elementary education in crime from such influences as the tabloid newspapers and bad economic conditions, and is perfected in his career by the reformatory and the prison. They emphasised certain reforms needed in the jury system and in court procedure. Yet there was hardly a suggestion of the modern biological conception of relative responsibility and its significance. Instead, there was much space devoted to the "crime wave," though the evidence to justify the continued use of this rhetorical phrase is hardly satisfying to the statistician.

In passing, I may remark that we know very little about whether crime is increasing or not. With 2,000,000 laws on our statute-books, including many of the Blue Laws of Colonial days, every one is a lawbreaker. Until some distinction is made between the sense and the nonsense involved in these legislative enactments, crude statistics on crime are meaningless. While we are making genetic suggestions, therefore, it may not be out of place to mention the fact that intelligence tests for our lawmakers might help the general situation.

I do not go so far as to say that all criminals are either feeble-minded or insane. On the contrary, some of them

are very brilliant men, who might have been led to see the reasonableness of some of the rules of conduct laid down by society if they had had training designed to this end. The basic idea put forward by Lombroso is completely discredited. No man is predestined to become a forger, a burglar, or a murderer. Nevertheless, there is a suspicion of truth in Lombroso. A great many criminal acts, perhaps the majority, are committed by people who are defective; and presumably from 60 to 70 per cent of these defectives owe their condition to heredity. Their inheritance has resulted in subnormal mentality or in psychoses. It is possible, also, as Lombroso maintained, that there is a significant correlation between these defects of the nervous system and certain more readily discernible physical characteristics; but this fact, if it is a fact, is not particularly important. As Goddard says, "the best material out of which to make criminals, and perhaps the material from which they are most frequently made, is feeble-mindedness." The moron is incapable of mastering abstract ideas, and moral ideas are abstractions. Such people naturally become the dupes of the more intelligent criminals, and, because of their mentality, are likely to be caught.

According to Goddard,¹ 100 admissions to the Rahway Reformatory showed 26 per cent of feeble-mindedness, even when border-line cases were excluded. Of 100 inmates of the Detention Home of the City of Newark, 67 per cent were distinctly feeble-minded. Of 56 girls released from a Massachusetts reformatory on probation, 52 were distinctly feeble-minded. They were the kind who would not stay in the homes found for them, who could not be taught to do, or would not do, the reasonable and sensible things which civilisation demands; they were, in fact, typical delinquents. And Goddard, who is well qualified to judge, believes that these data are normal. In his opinion, 50 per cent of the inmates of our penal institutions are feeble-minded.

¹ H. H. Goddard. *The Kallikak Family*, I. c.

Certain psychiatrists are of the opinion that Goddard over-emphasises feeble-mindedness and under-emphasises other psychopathic conditions as factors in crime. They also question whether as much as 60 per cent of these various defects are hereditary. What of it! Certainly many crimes and other social disturbances are due to conditions other than those which produce feeble-mindedness. The more lurid cases are due to dementia præcox, to maniac depressive insanity, and to compulsion neuroses. What proportion of the population is afflicted in a particular way, no one knows. As to how far their affections are hereditary, one need not hold any definite opinion. A good case could be made out for an hereditary basis in even the ordinary compulsion neuroses which yield fairly easily to treatment; but I am not inclined to press the point. It is more important to realise that mental defectiveness of one type or another characterises a whole host of antisocial persons and to be prepared to deal with it as such.

If my information¹ is correct, only two cities have psychopathic laboratories where offenders are examined as to their mentality before they are brought to trial—New York and Chicago. The New York department is headed by Professor L. E. Bisch, of Columbia University, who is aided by Doctor E. C. Rowe, the psychologist. In their laboratory all prisoners are examined sufficiently to indicate roughly those who may be feeble-minded or who are suffering from some type of psychosis. The suspects are then given a thorough examination and a detailed report is made. Only those who are found to be normal are turned back to the police officers for formal prosecution.

A similar system might well be adopted in every court in the country, not only because it is the sensible and fair thing to do, but also because it would give some of our officers of the law a much-needed course of education. Justice is traditionally blind, and those who grace the Bench are

¹ See *Jour. Heredity*, June, 1916.

vicegerents of Justice. What our judges require is an association with psychologists and psychiatrists until they become permeated with biological conceptions, until they realise that they are healers instead of headsman; then perhaps they may see their way clear to advocate a reform of the whole correctional system along scientific lines.

The recent brilliant penological study by Professor H. E. Barnes¹ gives some sound suggestions as to how this reform should be carried out. "Correctional institutions," he says, "should be regarded as primarily places for such treatment of the criminal types as will return them to society both determined and equipped to lead a law-abiding existence. The jails should be entirely places of detention and in no sense institutions for the reception of convicted criminals. There should be no promiscuous association of accused, first offenders, and veteran convicts. Those convicted of petty offences should, as far as possible, be kept out of penal institutions and handled through fines, probation, psychiatric clinics, and social guidance." All should be classified, segregated, and given appropriate treatment, with the object of complete cure or permanent seclusion, thus preventing the continuous return of inveterate criminals to their activities.

Obviously, these ideals cannot be attained unless social re-education and adjustment are seriously attempted. The offenders, patients, I was about to call them, must have mental training as well as physical care. They are in part victims of our inadequate social organisation. No cure can be expected unless different ideas and ideals are inculcated, and are proven to be desirable and capable of accomplishment. To this end occupational adjustment is necessary. If these people are to be changed from social liabilities to social assets, they must be given work for which they are fitted, work, therefore, in which they will be happy. In its turn, this means the establishment of agencies whose business it will be to obtain employment for the prisoner upon

¹ H. E. Barnes. *The Repression of Crime*. New York, Doran, 1926.

release, according to Barnes, and the development of a really efficient parole system in charge of trained sociologists.

I have no sympathy with Puritanism. I do not want to see the world made over after any peculiar pattern of beliefs. It were better, perhaps, to promote individualism than to stifle it with a multitude of stupid and inane laws, as is the fashion in the United States. Yet there are certain customs to which society has found it wise to demand adherence that it may live. These customs should be rational if reasonable men are to obey them. If there remains, then, a residuum of people who cannot or will not understand the desirability of playing the game according to the rules, they should be apprehended swiftly and dealt with as kindly and wisely as scientific procedure demands. But, after all, is this not locking the door after the horse is stolen? The most sensible policy would be a policy of prevention.

Obviously, social inadequacy can never be eliminated by any combination of eugenics and euthenics. The poor of body and the poor of mind will be with us always, as long as the world lasts. Yet Galton's precepts are sound. Their adoption would help the situation immensely. And something can be done to mitigate the disastrous effects of a bad heredity combined with a bad environment by renovating the latter. If the development of every child is watched solicitously, if medical, psychological, and psychiatric examinations are made as much a part of our social system as the public school, if recreation centres, boys' clubs, better housing, training in trades and profession, State employment agencies, unemployment insurance, and all the other panaceas so dear to the heart of the social worker are developed and utilised to their full value, then it can be said to us: "Ye did what ye could."

CHAPTER XIII

THE SURVIVAL OF THE UNDERMAN

MAN's irrepressible curiosity, his instinct for meddling, has been his greatest source of power; yet one is sometimes led to question whether this making free with Olympian forces entails no penalty. The most profound and impressive truth within our ken is the Order of Nature. All forces are in delicate adjustment with each other. Was it not Darwin who suggested, half humorously, half seriously, that the clover crop of England depended on the number of old maids? The old maids keep cats, the cats eat field-mice, the field-mice destroy bumblebees' nests, the bumblebees pollinate the clover flowers. This is the type of machinery that man is continually throwing out of gear. He interferes with the natural order in some particular, and a whole sequence of regulatory agencies is immediately disturbed. Looking out of my window, I can count five grey squirrels. They appear in such numbers because they are protected; and the consequence of this stricture on Nature can be traced in the rarity of various song-birds, in the prevalence of insects, and in a certain frayed condition of the vegetation. Such matters are perhaps negligible; but there are other instances where change is attended by more serious results. I refer to man's interference with the course of his own evolution.

A conspicuous though not wholly satisfactory example of a gradual change in biological selectivity is that which has accompanied the various revolutions in the art of making war. It was noted years ago by Herbert Spencer. During the earlier stages of man's history, war tended to eliminate weaker societies and to weed out the weaker members of strong societies. The most valiant and skilful defeated their

opponents. In modern times the strong-hearted and healthy are selected for slaughter, leaving the propagation of the race to those who are physically inferior. Possibly a complete triumph of civilisation, with gases and bombs annihilating whole populations, will restore the biological value of warfare; but the net result of the present system is organic retrogression.

True, the results of modern strife are not altogether dysgenic. The disease-rate of armies is high, and presumably the weaker succumb. Certain writers also argue that those who survive have a better opportunity for marriage and fatherhood than those who were left behind, on account of the partiality which women show for military heroes. Yet, as Holmes¹ remarks, we have to remember, in this connection, that the high incidence of venereal infection brought about by army life reduces the natural increase of soldier stocks.

Those who adopt the war-glory philosophy of Nietzsche or the biological-necessity thesis of Bernhardt place too much emphasis upon the preservation of the cultural status of the group, and too little emphasis upon the preservation of good germ-plasm. They forget that the units of selection are the hereditary traits of the individual. The chief advocates of the view that war promotes the survival of the fittest are thinking about the fittest society, the society of the moment. They are afraid of having superior races overcome by the wealth and numbers of inferior races. Such ideas are rather naïve. The essential difference between two races on different social planes lies in the inherent capacity of a few leaders who overtop their fellows. The race without such leaders does not increase in wealth and population. It reaches equilibrium at a low density of population and a small per capita average of this world's goods. It cannot become a menace to its neighbours. But the civilisation of the advanced society can become impaired, its position lost,

¹ S. J. Holmes. *The Trend of the Race*. New York, Harcourt, Brace, 1921.

if it does not conserve its best men. And one of the best ways to dissipate human resources is war. I do not wish to minimise the effects of group selection. Generally speaking, the nation showing the greatest general efficiency will be victorious in battle, provided its fighting strength is adequate. Thus many desirable virtues which are not altogether the product of a social heritage will be preserved. But there can hardly be a doubt that within this victorious nation the net effects of war are bad. Every battle leaves a nation with less good germ-plasm than it had before.

Such conclusions are not merely general biological deductions. Several investigations¹ based upon French statistics collected during the nineteenth century have shown an alteration in the physical character of the recruits following each war. Among other changes, there has been a significant decrease in height and weight.

There is similar evidence concerning war's aftermath available in this country. D. S. Jordan and H. E. Jordan² have studied the effect of the Civil War on the population of Virginia. They came to the conclusion that the men of highest character and finest physical quality enlisted first, fought the longest, and had the highest death-rate. The conscripts, who suffered less, were inferior in both of these qualities. Deserters and draft-dodgers were the least desirable element of the population, and had the highest survival rate. A larger proportion of university men than of any other group lost their lives in battle; a greater proportion of the "poor" whites of the hills survived. It takes no particular intelligence to see why Virginia lost her leadership in American culture and became what Mencken terms the "Sahara of the Bozart."

Man's early struggles with his environment, like his war-

¹ See particularly, G. Bodart. *Militär-historischen Kriegs-Lexicon*. Wien, Stern, 1909. G. Bodart and V. L. Kellogg. *Losses of Life in Modern Wars. Austria-Hungary, France*, by G. Bodart. *Military Selection and Race Deterioration*, by V. L. Kellogg. Oxford, Oxford University Press, 1916.

² D. S. Jordan and H. E. Jordan. *War's Aftermath*. Boston, Houghton, 1914.

fare against his own kind, left him the stronger for his struggle. Every advance in civilisation has tended to reduce that struggle. Clothes, houses, steam-heat, cooked food, medicine, surgery, sanitation, all have enlarged the meshes of the selective sieve and have allowed weaklings to slip through. Every alteration in social custom—better housing, minimum wage-laws, more desirable working conditions, improved educational facilities, public clinics—affect both the birth-rate and the death-rate selectively, and thus influence the trend of human evolution.

The net result of these changes, viewed humanistically, is good. People live longer and are, or ought to be, happier. It does not sound particularly exciting to say that the average length of life has increased; but this is merely an unemotional method of stating that people are fed better and housed better than formerly, that they work shorter hours and less strenuously, that they are healthier, that the struggle for existence is less intense. And that is what has happened. The one difficulty with the situation is this: the changes in vital tendencies bringing about these results have not affected the population uniformly. Evidence accumulates in support of the conclusion that the least desirable elements are supplanting the more worthy elements of the population. Society, says Mercier, is like a candle which burns out at the top and replaces itself from the bottom. Why? Because Nature has cared nothing for the individual, everything for the race; while man has cared nothing for the race, everything for the individual. By circumventing Nature's personal cruelties, man has largely eliminated the blessings formerly vouchsafed to the group.

We are making strenuous efforts¹ to preserve and to perpetuate the anomalies, the lack-wits, and the ne'er-do-wells, who would not survive a natural struggle. "The first part of this responsibility, preservation, society ought to accept in the interest of its own ethical development; the second

¹ Cf. E. M. East. *Mankind at the Crossroads*. New York, Scribners, 1923.

part, perpetuation, is a sad mistake. And if the still small voice of common sense ever makes itself heard, there will be as much recognition of and aid for the efficient as there is now for the inefficient; and there will be some slight police regulation and a great deal of educational restriction of the birth-rate among those who cannot bring healthy, capable children into the world. The first change will show intelligence, the second will bespeak wisdom. The public money is now spent largely on the indolent, the pauper, and the criminal. Institutions are provided for the lame, the halt, and the blind. There are almshouses by the score. There are free hospitals and public clinics. There are schools for feeble-minded and backward children. This type of social sanitation may be wholly proper, though in part the results are of questionable value; but one wonders why a whole-souled benevolence must include the encouragement of the recipients to produce increasing battalions of their own kind to weigh down the burden of the next generation. And one is entitled to ask why this benevolence stops at just the wrong place. Why are there not schools for precocious and brilliant children? Why do the ambitious and industrious have to fight so hard for education and for health? Why are the rotten timbers of society repaired and painted, while the more solid framework is abandoned to wind and weather? Why is the producer repressed and his fertility restrained to make room for the parasite? One of our prominent social workers is quoted as saying that every child is worth \$5,000 to society. Stuff and nonsense! Some of them are not worth 5,000 brass farthings—they are liabilities, not assets; others are worth golden millions. If prosperity is to be promoted, the assets should be increased and the liabilities reduced."

I do not argue that the "programme of social hygiene," as Havelock Ellis calls it, which becomes more and more socialistic as the years go on, should be allowed to fail. By no means all changes in social custom are dysgenic. In

Mankind at the Crossroads I have explained at some length how progress in serology and immunology can proceed to a point where natural immunity to certain diseases is no longer necessary. We merely do away with the parasite, and then forget that we were ever afraid of it. And there are many other social advances belonging in the same category. Yet in all too many instances a dysgenic residuum inheres sufficient to insure rapid racial deterioration if the results obtaining are not countered by other measures. We must seek and find ways to further racial evolution as well as to prevent it.

How this is to be done is a grave question. People are so suspicious of race-betterment proposals. Galton expressed the truth nearly half a century ago when he said: man has already taken advantage of the evolutionary principle for his own personal gain, "but he has not risen to the conviction that it is his religious duty to do so deliberately and systematically" for the benefit of future generations. There is a high differential birth-rate in favour of the least intelligent classes of the population sufficient to make a pessimist of any one conversant with the facts. Its serious consequences can be prevented only by teaching birth-control where it is most needed as a public policy, and this we do not seem inclined to do. Preaching large families among the more intelligent people is hardly a solution. The wise will never compete with the foolish in the matter of reproduction.

The differential birth-rate is a matter important enough to consider at some length, because there is evidence that it was a major factor in the death of several ancient civilisations, and because there is little likelihood of a new and greater civilisation replacing that of the present should it also decline and fall. The last statement may need explanation. Hitherto, barbaric races of high ability have been ready to seize the torch of learning when it fell from senile hands. There is no such race to be found to-day.

The capacities of the various peoples of the world have been tested. We know fairly definitely what they are. We can even make a reasonable guess as to what they will do in combination, for nearly every racial cross possible has been made at one time or another. Moreover, the potentialities within each race are constantly diminishing, owing to the segregation of the best germ-plasm from the lower levels. The early history of man was amalgamation. The result of amalgamation was segregation and recombination of genes. The best gathered at the top and was sterilised and eliminated. New blood was brought in, and civilisation continued until all of the interracial combinations were tried. There remained good germ-plasm which had not had an opportunity to rise. Modern democratic governments gave it the chance. New combinations were made. Segregation and recombination of genes continued. The sterilisation at the top continued. Thus we are getting a larger and larger quantity of human dregs at the bottom of our national vats.

There are a great many statistical investigations on this subject. The first is that of Heron,¹ who published a memoir in 1906 "On the Relation of Fertility in Man to Social Status, and on the Changes That Have Taken Place during the Last Fifty Years." Heron's inquiry was suggested by Karl Pearson, who, some years before, had shown² that 25 per cent of the married population of England produce 50 per cent of the next generation—a conclusion corroborated by Powys,³ using Australian data. The inheritance of physical and mental traits being granted, it is important to learn something about the more fertile and the less fertile classes.

¹ D. Heron. "On the Relation of Fertility in Man to Social Status, and on the Changes That Have Taken Place during the Last Fifty Years." *Draper's Company Research Mem., Studies in National Deterioration, I*, London, Dulau, 1906. Quoted by permission.

² K. Pearson. *The Chances of Death*. 2 vols. London, 1897.

³ O. A. Powys. "Data for the Problem of Evolution in Man. Anthropometric Data from Australia." *Biometrika*, 1: 30-49, 1901. "On Fertility, Duration of Life, and Reproductive Selection." *Biometrika*, 4: 233-285, 1906.

Heron utilised statistics from the County of London, and corrected them in a way which eliminated all serious mathematical fallacies. As measures of wealth and education, he used (*a*) the proportion of professional men in the male population, (*b*) the proportion of female domestic servants in the female population, and (*c*) the proportion of female servants per family. As indicating poverty and general lack of culture, he used (*d*) the proportion of general labourers among the occupied males, which was taken as a measure of how far the district is the abode of the lowest class of labourers, and (*e*) the number of pawnbrokers, general dealers, etc., per occupied male, as showing the degree of improvidence. In addition, he determined (*f*) the amount of child labour, (*g*) the proportion of people living more than two in one room, and (*h*) the infant mortality. The data were for the years 1851 and 1901.

It is unnecessary here to report the mathematical coefficients of association calculated. The conclusions are given in Heron's own words:

As far as the present investigation goes it demonstrates, I think, conclusively that for the London districts there is a very close relationship between undesirable social status and a high birth-rate. In districts where there is overcrowding, where there is a superabundance of the lowest type of labour, where it is needful to employ many young children in order to earn daily bread for the family, where infantile mortality is greatest, there the wives of reproductive ages have most children. Where there is more culture and education as shown by a higher proportion of professional men, where there is more leisure and comfort as shown by a higher percentage of domestic servants, where the traders who appeal to the improvident and thriftless are fewer in number, there the birth-rate is least. Again, where there is more general pauperism, where signs of bad environment like phthisis are prevalent, where pauper lunatics are most plentiful, there the birth-rate is highest. Cancer alone of the undesirable physical conditions dealt with so far seems more prevalent in the prosperous and cultured districts and to be associated with a lower birth-rate.

Nor is the higher birth-rate of the undesirable elements compensated by the higher death-rate. The net fertility of the lower status remains higher than that of the superior status.

The relationship between inferior status and high birth-rate has practically doubled during the last 50 years, and it is clear that in London at least the reduction in the size of families has begun at the wrong end of the social scale and is increasing in the wrong way. I have brought forward evidence enough to show that the birth-rate of the abler and more capable stocks is decreasing relatively to the mentally and physically feebler stocks.

A second memoir, "On the Correlation of Fertility with Social Value," was issued by the Galton Laboratory for National Eugenics in 1913 as a co-operative study, by E. M. Elderton, A. Barrington, H. G. Jones, E. M. Lamotte, H. J. Laski, and K. Pearson. It dealt with early twentieth-century statistics from Blackburn, Preston, Glasgow, Birmingham, and Lancaster. The results were similar in every case. There was a sensible degree of association or correlation between large families and bad conditions. The results from Blackburn and Preston are typical.

CORRELATED PAIR	GROSS FAMILY FOR CONSTANT AGE AND EMPLOYMENT OF MOTHER
Large family and dirty home	0.41 $\pm$.02
" " " insufficient food	0.35 $\pm$.03
" " " small number rooms	0.15 $\pm$.03
" " " unskilled work of father	0.23 $\pm$.03
" " " low wage of father	0.23 $\pm$.03

Many persons will insist that these conditions can be entirely changed by raising wages. I shall not argue against such naïve views. Those who cannot or will not see that in spite of the obvious flaws of our economic system, social value is indicated roughly by the measurements used here, must be left with their opinions. I am content to give the conclusions of the authors:

"Sundry sentimental sociologists" have asserted that biological laws do not apply to human life, but they have made no attempt to meet the

evidence (1) that in man physical and mental characters are alike hereditary, (2) that under dominating economic and social tendencies of to-day the physically and mentally fitter members of each social class leave the fewer progeny, and (3) that the physically inferior and mentally less fit members are directly encouraged by a vast system of charitable and poor-law institutions to provide a large supply of cheap but inefficient labour. Our economic conditions at the present time are such that on the average without these institutions wages are wholly inadequate to maintain the large families of the low-waged working classes, while the high-waged working classes, representing by far the most valuable element in the community—the stocks which would propagate physique and skill—are refraining in increasing numbers from the family warranted by their wages. Any nation under such conditions must deteriorate.

The same correlation between fertility and social status exists in countries other than England. In the latter part of the nineteenth century Bertillon¹ found that the birth-rates in Paris, Berlin, and Vienna per 1,000 women of child-bearing ages were 108, 157, and 200, respectively, in the very poor districts, and that these birth-rates dropped regularly in the richer districts until the figures 34, 47, and 71 were reached in the districts occupied by the very rich. The United States is not an exception to the rule. Nearing,² studying Philadelphia, found that the birth-rates ranged from 18 per thousand in the best residential districts to more than double that figure in the poorer quarters. Among American-born factory workers it was 24.5 per thousand; among unskilled foreign workers it was 41.9 per thousand.

According to the official statistics compiled by the Registrar-General for Britain in 1911, the fecundity for all durations of marriage is very different in the various occupations. If the fecundity for the general population is rated 100, then that of the professional classes is roughly 70, while that of the unskilled labourers is roughly 115. When it is

¹ J. Bertillon. *La dépopulation de la France; ses conséquences, ses causes, mesures à prendre pour la combattre*. Paris, Alcan, 1911. Earlier works are cited here. See also *Bull. Inst. Internat. Stat.*, 11: 163-176, 1899.

² S. Nearing. "Social Decadence." *North Am. Rev.*, 197: 629-639, 1913. See also *Social Adjustment*. New York, Macmillan, 1911.

realised that the differential in the marriage-rate is fully as high as the differential in the birth-rate in favour of the unskilled, and that the age at marriage for the professional classes is about four years higher, it is not difficult to see that Britain pays less attention to the qualities of her human stock than she does to her cattle.

In the United States¹ the marriage-rates, the age at marriage, and the birth-rates among the graduates of 15 or 20 colleges have been investigated. Of the graduates of the women's colleges, only about half marry—on the average, two years later than women who do not attend college—and produce less than two children per family. The graduates of the men's colleges are somewhat more inclined to matrimony and a little more prolific. About 75 per cent of them marry, and these become the fathers of from two to two and one-fourth children per family.

Cattell² has been at some pains gathering vital statistics concerning the most distinguished American men of science. They show a high marriage-rate, but they do not become fathers at all frequently. Nearly 90 per cent marry, yet completed families average only 1.88 children. "A scientific man," says Cattell, "has on the average about seven-tenths of an adult son. If three-fourths of his sons and grandsons marry and their families continue to be of the same size, a thousand scientific men will leave about 350 grandsons to marry and transmit their names and their hereditary traits. The extermination will be still more rapid in female lines." To appreciate what this elimination of blood lines means to the country, one must remember that the researches of Galton, of Woods, and of Cattell all agree that the sons of these notables are at least 50 times as likely to attain

¹ Many of these investigations are reported in the *Journal of Heredity*. An excellent bibliography on this, as on other phases of human heredity, is found in a *Bibliography of Eugenics*, by S. J. Holmes, Berkeley, Univ. of Calif. Press, 1924.

² J. M. Cattell. "Families of American Men of Science." *Pop. Sci. Mon.*, 86: 504-515, 1915; *Sci. Mon.*, 4: 248-262; 5: 368-377, 1917.

similar eminence as are the sons of the average Mr. John Doe.

At the other end of the scale, whether that scale is financial or intellectual, there is great fertility. Such people marry young and frequently, and reproduce their kind with the steady punctuality of rabbits. There are about 28,000,000 people in the United States who are unable to read and to understand ordinary newspaper articles or to write intelligible letters, 25 per cent of the total population, if the army examinations were accurate. Possibly some good germ-plasm is to be found within this group. We do not provide equal opportunity in this country, despite the slogans of the Colonial Fathers. Yet it is hardly probable that any great proportion of these semi-illiterates could rise much above their present levels. In large measure their status is determined by their intelligence. The army tests showed that about 5 per cent are feeble-minded and about 20 per cent too stupid to imbibe the small quantity of learning represented by six grades of the public-school curricula. Thus there are 6,000,000 within our borders who cannot support themselves adequately, and 23 or more millions who cannot take part intelligently in governmental affairs. And every investigation indicates that these people are producing from one and one-half to twice as many children as those who are proportionately above the national intellectual average.

The reckless fertility of the irresponsible cannot be disputed; they are outbreeding the more competent portions of the nation; yet it will not do to take an overpessimistic view of the situation. There is a higher degree of functional sterility among the negroes than among the whites. And among the lowest classes of the white population there are a few more childless families than among the intellectuals. Reproducing women of Nam and Juke families have over 4 children each, but 15 per cent of the Juke women are childless. This is a higher percentage of sterility than is found in the general population, though not so high as is

found among graduates of Harvard. Furthermore, we have not succeeded yet in equalising death-rates. In spite of the efforts of competent physicians and sanitary experts to bring the produce of undesirable stocks to maturity, there is still a differential death-rate in favour of the more intelligent. In addition, it should be noted that the rural communities, peopled by stocks which have been furnishing the cities with many of their best men for years, are holding their own fairly well.

Thompson's¹ study of *Race Suicide in the United States*, based upon the Census of 1910, showed that 10,382,634 urban white women of child-bearing age had 3,966,957 children under 5; while 8,877,985 white women of the same age group in rural districts had 5,355,957 children under 5. Thus in the rural districts, where about 80 per cent of the people are of Old American Stocks, there were 603 children per thousand women of child-bearing age; while in the urban districts, where less than 40 per cent are natives of native stock, there were 382 children per thousand women.

Ten years later, I find no marked change in the situation. The percentage of foreign-born white to total white population had dropped from 19.3 to 14.5, the percentage of people in rural districts had dropped from 51.7 to 46.6; yet country-bred children had not become rarities. The 12,756,691 urban white women of child-bearing age had 4,995,277 children under 5 years; the 9,260,910 rural white women had 5,378,644 children under 5 years. The disproportion was less than it was in 1910, however; since the relative number of children among urban women had risen from 382 to 392 per thousand, and the relative number among rural women had dropped from 603 to 581 per thousand.

Such statistics are worth pondering. Until 50 years ago the white immigration to this country, the Old American Stock, was largely from the countries of northern Europe—

¹ W. S. Thompson. "Race Suicide in the United States." *Am. Jour. Phys. Anthropol.*, 3: 97-146, 1920.

British, Scandinavian, and Teutonic. The recent arrivals came preponderantly from southeastern and eastern Europe. A generation ago the immigration from northern and western Europe was over 70 per cent, and the immigration from southern and southeastern Europe was less than 20 per cent; in 1914 the figures were just reversed. Each ethnic group has been a mixture of the good and the bad; but by and large the earlier immigration was the best. When one makes such a statement, a flood of protest is immediately turned loose at the unlucky writer. He is an upholder of the "Nordic myth"! He is making unworthy attacks on the nationals of great countries! It is unfortunate that so many people should have such overdeveloped inferiority complexes. We cannot evade the truth for any such reason. There are undesirable English, Scotch, and Germans in this country, just as there are desirable Italians, Greeks, and Armenians; but on the average the Nordics and the Jews make the best showing in proportion to their numbers. The studies of Cattell, of Woods, and of several others as to the relative contribution of great men by the different races making up our population show an extraordinary balance in favour of the Nordics with the Jews a close second. When the Jews have had relatively as great an opportunity to produce cultural leaders, they may take first rank. The nationals from southern and southeastern Europe, on the other hand, have produced but few notables. The latter, being more recent immigrants, have not had as good a chance to demonstrate their worth, perhaps. It is to be hoped that this is a sufficient reason. But one has his doubts. In the first place, the Jews have had as few opportunities as any race, and a goodly percentage of them have risen from the ranks. In this connection it may also be noted that the farm-born Nordic, who has made such heavy footprints on the sands of his Time, has had to scurry harder for his education, for his opportunity to make good, than the foreign-born of our great cities. In the second place, the intelligence

tests given to the army recruits show an extraordinary superiority of the north Europeans over the south Europeans that is too great to be explained away.

The Italian or the Greek or the Serbian who has risen above the common level of his race need not be disturbed or insulted by this showing; nor should the stupid Nordic be exalted. No one deserves any particular credit because he has or has not the proper heritage with which to make his mark in the world. It is more important to inquire why the facts are what they are. It is not because one race averages so much higher than another in desirable qualities. There are differences in levels, of course, but they are small. No one fact of heredity impresses the student more than that the differences between individuals within a given ethnical stock are enormous as compared to the average difference between stocks. One might assume an equal distribution of intelligence in the homelands of our immigrants, therefore, and still expect to get the result found. It devolves because the early immigrants came in great proportion from the *best* stocks their countries afforded, while in recent times they have come very largely from the *worst* stocks. In former times people came to the United States to avoid religious and political persecution, or to carve an empire out of the wilderness; during the last generation they have come because they were pressed out by the existent economic competition in their native land. I shall recur to this matter in the next chapter.

To resume, the good germ-plasm in the country has been and is rising to the top, going to the cities, and there being sterilised. The foreign-born of the cities are undergoing the same history. Eastman¹ found that the births to white mothers, per thousand of the population, in New York State exclusive of New York City in 1916 were: native, 17.2;

¹ P. R. Eastman. "A Comparison of the Birth-Rates of Native and of Foreign-Born White Women in the State of New York during 1916." *Bull. N. Y. State Dept. Health*.

foreign, 43.8; English, Scotch, and Welsh, 19.1; Italian, 91.6; Russian, 88.6; Austro-Hungarian, 89.9. Several other investigations have yielded similar results for New York City itself. The contrast between native and foreign-born women and between Nordic and non-Nordic women in the matter of reproductivity is extraordinary. But this is not the specific point to note. The daughters of these foreign-born are native-born, and the birth-rate which they exhibit is from 40 to 60 per cent lower than their mothers exhibited. Such a drop in fertility is desirable, almost inevitable; but the sad thing is that it is differential as in every other class of the population. The better-grade sons and daughters of our immigrants, those who are welcome additions to our population, show birth-rates which are less than the average for the country as a whole; the stocks which produce no high-grade scions continue to breed with more nearly their habitual rapidity.

The general conclusion of most students of vital statistics is that those elements of the population exhibiting sub-normal mentality show the highest gross fertility, while those elements having the greatest intellectual capacity court extinction by their relative sterility. With the existent hereditary mechanism the undesirability of this condition would seem to be obvious, since a good germ-plasm once extinguished cannot be recovered by any known process of alchemy. Raymond Pearl, however, has come to the defence of the system. He believes that it is a good thing.

Pearl¹ has studied the families of the United States in which a birth occurred in 1923, where the father was 45 or older, segregated according to occupation. He selected this age group of fathers in order to obtain completed families; but in so doing he probably did not get a fair cross-section of the population. The 100,000 Americans of age 45 or more who became fathers in 1923 are likely to represent either persistently fertile families or late marriages; and this

¹ Raymond Pearl. "Differential Fertility." *Quart. Rev. Biology*, 2: 102-118, 1927.

fact might vitiate the whole investigation. Assume, for example, that 10 per cent of professional men and 60 per cent of miners do not limit their families; then selected statistics taken largely from these particular subgroups do not tell us much about differential fertility.

Taking the figures as they come, however, one finds that the Professional, Clerical, Trade, Domestic and Personal Service, Public Service, and Transportation occupational classes do not exhibit a sufficient fertility to maintain their present representation in the population. The classes doing heavy labour in Manufacturing, Agriculture, and Mining reproduce in excess of their quotas, and it is from this excess that the deficiencies in the other classes must come if proportions are to remain the same.

This situation, says Pearl, is not so wholly deplorable as it is supposed to be. We not only need more people who live by their muscles than we do people who live by their wits, but we need to replace them more frequently because their economically productive life is shorter. They will be replaced as required, he believes. "The almost infinite manifoldness of germ-plasmic recombinations can be relied on, I think, to produce in the future, as it has in the past, Shakespeares, Lincolns, and Pasteurs from socially and economically humble origins."

I should like to be as optimistic as Pearl, but I do not believe that the facts warrant such optimism; though I do agree with him in deploring "the eugenic condemnation of whole social or economic classes, either directly or inferentially, by the contention that only certain classes, such as college graduates, are eugenically desirable."

The difficulty of appreciating the significance of the differential birth-rate, as I have remarked before, comes from a failure to see that those relatively permanent bodies, the genes, are the units to be considered. The irrepressible Mencken,¹ who likes to add biological criticism to all his other criticisms and who speaks of the cow as *Bos taurus*

¹ H. L. Mencken, in one of his syndicated press articles. April, 1927.

that one may realise his fitness for the task, makes this mistake when he writes of genetics and eugenics. Eugenics, he says, "is mostly blather," because no one knows what superiority is, because superior individuals come from inferior social levels at the call of the times, because they can come as sports or mutations, and because only a few superior men are necessary to make a great civilisation, anyway. All of which is reminiscent of a man I once heard who was holding forth on the technical deficiencies of Paderewski while picking out "Yankee Doodle" on the piano by main force and awkwardness.

Superiority is a matter of a mind and body above the average. It comes by a proper combination of genes, not by mutation. And a civilisation to be worth while needs a high rather than a low average in these qualities. Now, good combinations of genes rise to the top of the social mass like cream, and when they are skimmed off by relative sterility the mass is just that much poorer. Economic worth, ability to gain a college degree, eminence, are simply general indications of genetic fitness. They are among the best criteria we have of social value. We use them not because they are absolute measures but because they are serviceable measures. And when we study the reproductivity of those who stand out above the herd by these measures, we find that it is very low compared with the reproductivity of those who segregate at the other end of the scale. The trend is obvious. For a while, possibly for many centuries, there will be good genes pervading the germ-plasm of the general population awaiting combination into the superior individual. But one cannot watch the extinction of this germ-plasm whenever it does result in a high-class human product without realising that a tragedy is being enacted. A continuous process of subtraction has never been discovered which leaves the subtrahend as large as before. I refer the reader again to Havelock Ellis's work on *British Genius*. When men of eminence rise from a lower stratum of society,

they leave that element poorer. In every generation it produces fewer and fewer notables.

The predictor¹ of calamity, however distant, is always ridiculed. Greece and Rome fell. Previous to the fall in each case there was an influx of immigration, a freeing of fecund slaves, and a decline in the birth-rate more marked in the upper classes. In the middle of the second century B. C., Polybius said that the population of his country had diminished, although unchecked by war or pestilence. At the end of the first century A. D. Plutarch stated that the whole of Greece could not raise the 3,000 soldiers which the little town of Megara had sent to the battle of Salamis. Lucan the poet laments that Rome is not peopled by her own citizens, but by the scum of the earth. A similar passage is found in Juvenal. Rome grew rich. She emancipated the more cultured slaves. She welcomed peoples of all kinds for the good of the moment. Hence, one finds Augustus paying 1,000 sesterces for each child, in order, if possible, to check the declining birth-rate. But without success! The old families died out. An increasing number of barbaric names were to be found in the Senate. Even the later emperors were barbarians. Trajan, Hadrian, and Marcus Aurelius were Spaniards. Antoninus Pius was a Gaul. Septimus Severus was born in Africa; his successors were Syrians. And Greece and Rome fell. Is there no connection between the change in population and the fall? One can imagine the Greek and Roman philosophers predicting retrogression, degeneration, and final decay from a differential birth-rate, for the leading thinkers of these countries were not ignorant of the general principles of biological selection. One can also imagine how the people held their sides and laughed at these calamity-howlers.

¹ In this paragraph I follow M. P. Nilsson, "The Race Problem of the Roman Empire." *Hereditas*, 2: 370-390, 1921.

CHAPTER XIV

IMMIGRATION

IN the attenuated sketch of the immigration problem appearing in this chapter, the strictly genetic phases of the subject are treated altogether inadequately, while valuable space is devoted to mentioning points which have no direct connection with heredity. In extenuation of this double fault, let me plead the conviction that one cannot evade the biological in any consideration of immigration. The consequences of migration are genetic, whatever may be the causes. Future human values are concerned, and these are of more importance than the economic or political exigencies of the moment. Yet our views are influenced by many matters having loose and tenuous relations to each other. For these reasons I have elected to discuss briefly certain points which, as a student of immigration for a quarter of a century I have found to be of determining value, without regard to whether their immediate genetic implication is rigorously exact. As an American citizen, it is inevitable that my views should be coloured by an analysis of immigration as it affects the United States, and thus should exhibit some degree of provincialism; but I think it is fair to say that the theses advanced apply likewise to immigration in general.

The immigration during the seventeenth and eighteenth centuries to what is now the United States was small even on a percentage basis. At the fourth census, taken in 1820, the total population was just short of 10,000,000, and not until 1825 did the annual entries reach 10,000. Then came a swift increase to a peak of over 400,000 in 1854. A sudden drop followed to half this figure in 1855, and this depression lasted until the close of the Civil War. In 1866 the influx

reached 300,000, continuing at about the same amount until 1875. For five years thereafter another depression existed, succeeded by 14 years of extensive immigration activity culminating in the arrival of nearly 800,000 people in 1882. Business conditions being unfavourable for the next six years, only about a quarter of a million newcomers annually came to cast their lot here; but with the beginning of the twentieth century immigration rose rapidly, reaching nearly 1,300,000 in 1907.

The character¹ of the white population in 1790, according to the estimates of the census officials, was 83.8 per cent English, 7.0 per cent Scotch, 5.6 per cent German, 1.9 per cent Irish, and a little over 1 per cent Dutch. Thus practically all of the original citizens of the United States were of north European origin. During several decades of the nineteenth century the entries continued to be preponderantly British, with Germany, France, and Spain contributing significant figures. Before the middle of the century was reached, however, the immigration from Germany began to rise rapidly. Then came an Irish wave, and finally a wave from the Scandinavian countries. Between 1820 and 1923, 5,569,000 Germans and 2,220,000 Scandinavians were received, as compared with 8,431,000 Britons. Small contingents arrived from other countries, of course, but until 1882 the country was largely Nordic. The only significant non-Nordic contribution was the Mediterranean contingent from southern Ireland.

In 1882 the source of the stream began to change. Peoples from southern and eastern Europe arrived in ever-increasing numbers. And as the impetus of the new immigration rose, that of the old diminished. In 1914 the new immigration

¹ For further information on this subject, see H. P. Fairchild, *Immigration*. New York, Macmillan, 1913. *The Melting-Pot Mistake*. Boston, Little, Brown, 1926. Also J. R. Commons, *Races and Immigrants in America*. New York, Macmillan, 1920. P. F. Hall, *Immigration and Its Effects upon the United States*. New York, Henry Holt, 1906. J. N. Jenks and W. J. Lauck, *The Immigration Problem*. New York, Funk & Wagnalls, 1917.

made up nearly 87 per cent of the total. The constitution of the population in 1920 shows the consequences. The total was then 105,710,000, of which 94,821,000 were white, divided into 58,422,000 natives of native parentage and 36,399,000 persons of foreign white stock. The foreign-born people contained in the last group amounted to 13,713,000. The foreign white stock of racial origin similar to the older immigration consisted of 3,269,000 from the United Kingdom, 4,136,000 from Ireland, 2,948,000 from the Scandinavian countries, and 7,260,000 from Germany, with another million or so scattering. The influence of the newer immigration was shown in 3,130,000 people from Austria, 1,111,000 from Hungary, 4,167,000 from Russia and Finland, 3,337,000 from Italy, 848,000 from French Canada, 1,756,000 from English Canada, and 725,000 from Mexico, plus about 1,000,000 representatives of other nations.

The sociological and political difficulties confronted in dealing with this enormous influx of aliens led first to attempts at selection, exclusion being based largely upon mental and physical defectiveness. These laws were of no effect in moderating the inflow, and were difficult to administer satisfactorily. Demands for increased restriction became more and more insistent, therefore, sponsored chiefly by the American Federation of Labour. Congress responded by adopting, as a temporary expedient, a law providing that the total immigration of persons of a given nationality during any fiscal year should be limited to 3 per cent of the foreign-born of that nationality resident in the United States in 1910. Vociferous howls were raised against this enactment by alien organisations, those of the Hebrew and the Italian societies having the greatest resonance; but public opinion rapidly crystallised in its favour.

By the time Congress was ready in 1924 to put the Act into permanent form, however, the native majority of the country had bethought itself that there was no particular justice in discriminating against itself. It was proposed,

therefore, to replace the quotas based upon the number of foreign-born by a definite annual total from quota countries of 150,000 to be distributed in the proportion in which people originating from these countries were to be found in the United States in 1920. This change was to go into effect on July 1, 1927. In the meantime the old quota plan was to be continued, reduced to a 2 per cent basis and determined by the alien representation in 1890 instead of 1910.

Powerful influences have been at work in the interval endeavouring to defeat the national-origins provision of the law *in toto*, and to render the remaining stipulations as ineffective as possible. The open argument is the alleged impossibility of determining national-origin quotas from census data. Congress directed the determination to be made "as nearly as may be"; but an admitted probable error of about 1 per cent has been magnified until many people have been led to believe that a satisfactory computation cannot be made in this manner. The true reason for the reaction against the law is the realisation by certain alien organisations and by the Knights of Columbus that it does not make an unfair discrimination in favour of race or religion. On the contrary, it gives the people who are now in the country the opportunity to invite citizens of other nations to the country in the exact proportion in which they are now represented.

The Immigration Act of 1924 has been approved by those who believe in restriction, but it is singularly ineffective from this point of view because its provisions do not apply to natives of countries of the western hemisphere. According to the Commissioner's latest report, the grand total of aliens admitted during the fiscal year ending June 30, 1926, was 496,106. There were 88,758 non-immigrant aliens included in this figure, it should be noted; but exclusive of these transients there were 249,916 non-quota immigrants as against 157,432 quota immigrants.

Immigration has been curtailed, since the State Depart-

ment reports 1,501,155 applicants for immigration visas on January 1, 1927. In Italy alone there are 840,300 applicants, with Great Britain listing 153,275 and Poland 102,250. But it seems queer that our worthy Congressmen should not be able to see that by failing to place all countries under quota, they have diverted the source of the immigrant stream from Europe to South America, Central America, Mexico, and the West Indies. During the last quarter of a century 135,000 negroes have been admitted to the country, most of them from the West Indies. In addition, 370,000 Mexicans have entered since 1920. The Mexicans are very largely peons of mixed blood, characterised by low standards of living, and antisocial qualities. Their presence is causing the rapid development of new social problems and a new race antagonism in the southwest. A few rapacious land-owners entice these labourers in, and give them work during the agricultural season. At the end of the season they are abandoned to their own devices, and soon flood the penal and benevolent institutions.

There is one other phase of immigration to the United States which has not been settled to the satisfaction of every one concerned. Nearly half a century ago the Chinese were specifically excluded by law. Later, Hindu immigration was prohibited, originally by a rigid interpretation of the general law, and in 1917 by a "geographical delimitation clause" applicable to the greater part of eastern Asia save parts of China and Japan. The avowed intention, in spite of the presence of the negro, was to make this a white man's country. Japan was the only favoured non-white nation. Instead of a law respecting Japanese immigration, Secretary Root had the presumption to sign the famous Gentlemen's Agreement, the terms of which were never divulged to the people he was serving. It is generally understood, however, that the United States abandoned the sovereign right of determining the persons to whom she would open her gates in return for an agreement by Japan generally

to refuse passports to labourers. The law of 1924 annulled these special privileges accorded to Japan and put her citizens in the same category as the Chinese. Japan has taken the Act as a national insult, though it is difficult to see any basis for the feeling. It is racial discrimination, certainly; but not national discrimination.

This, in brief, is the immigration situation in the United States. As a result, the citizens here are divided into two camps, the one hoping to have the loopholes in the present law reduced by applying national-origin quotas to every country, the other believing that the law is too drastic and should be weakened phrase by phrase.

Antirestriction fundamentalists belong to three groups. The first and largest group consists of those who wish to transport their entire kindred here, root and branch. In part this desire grows out of a feeling of sympathy for personal friends and relatives that is easily understood; but I have come to the conclusion, after a good many discussions with those concerned, that the reaction is usually engendered by an inferiority complex. Certain newcomers wish to strengthen their numbers until they can inspire fear as a more or less isolated group. The second division includes the heads of those steamship companies to whom third-cabin fares are more important than the well-being of this country, and other avaricious souls who seek to exploit the foreigner for their own gain. In the third class are those who have imperialistic views for their church.

All three classes have found it advisable to use the sentimental appeal as their main argument because they so often succeed by this means in winning the support of those simple folk whose souls are racked with pity at the wholesale misery abroad in the world—people whose emotions do them credit, but whose intelligence is hardly to be respected. The type is a common one—those who toss their small change to the halt and the blind, who collect doles for the very poor, thus satisfying their own peace of mind, without

the slightest thought as to the ultimate effect of this practice on the recipient of their favours or on the causes which have produced the condition they seek to alleviate! As Havelock Ellis says, such people are really the most uncharitable of men.

One should endeavour not to be activated merely by emotional stress. It is very easy to have one's imagination stirred by facile but shallow-pated writers. And it is a natural reaction, after a vivid picture of troops of unfortunates begging our hospitality at Ellis Island, to demand for them an open door to freedom and opportunity in the United States. Before yielding to this hypnosis, however, one should inquire whether the admission of such people will really make them happier, whether their emigration will give any permanent relief to the country from which they came, and, more important still, what will be the effect of their immigration economically, culturally, and biologically on the country that receives them.

Immigration restrictionists also belong to three groups. There is first the old-stock north European who has been intrigued by the idea of great inherent superiority in the race to which he belongs. The second division comprises those whose arguments are wholly economic. They want to avoid the competition of the alien. The third class includes many geneticists, sociologists, and population students who believe that continued extensive immigration will prevent the United States from developing into a strong, united country holding the intellectual respect of the world by the quality of the accomplishments within its borders. The arguments of this group are the ones I will outline here.

After the fashion started by President Wilson, I wish to impale my readers upon a series of points of logic—the pain being tempered by reducing the number from 14 to 9. Those who are convinced of their soundness will appreciate the desirability of aligning themselves against the successive attacks on the present law which are being made by well-

organised lobbies, and of supporting efforts to strengthen it in its weak spots. No citizen should avoid joining one party or the other. The antirestrictionists are united, the restrictionists are not. And the former are not content with lawful means of modification. Political leaders of all kinds, from ward-runners to Senators, are constantly pressing to obtain the admission of aliens who are inadmissible under the law. In his recent book on *Immigration Problems*,¹ Doctor Victor Safford, who knows his facts from a long experience at Ellis Island, states that a single agency at Washington boasts of obtaining the entry of 160,000 individuals legally barred from the country.

1. *Emigration, forced as an economic necessity by population density, affords no permanent relief to the homeland because the ensuing birth release re-establishes the old equilibrium.*

This statement is sometimes known as the second law of Malthus. It probably came to the mind of the English rector as an obvious deduction from the law of population increase; but not being satisfied with supposedly obvious deductions, he endeavoured to secure statistical proof for his statements and visited many of the countries of Europe with this definite object in view. I should not be quite ready to maintain that Malthus obtained a valid proof of his theorem from the then existing data; but the hundreds of studies of birth-rates and death-rates made during the past century have settled the matter beyond a reasonable doubt. When there are wars, such as the Franco-Prussian War and the World War, the birth-rate decreases during the time of stress; but as soon as peace is declared, the birth-rate rises and continues at a higher rate than previously until the losses have been made up. To-day, less than ten years after the close of the World War, if one plots the rate of population increase for the various countries involved, or for Europe as a whole, he finds that those four sad years made

¹ Victor Safford. *Immigration Problems*. New York, Dodd, Mead, 1925. Quoted by permission.

only a slight disturbance. Each country had an established curve of growth. From 1914 to 1918 there were depressions below the normal, from 1918 to 1922 there were waves of increase above the normal; and then the curves settled back to the old steady rates existing earlier. A similar phenomenon occurs when there are famines, when there are political or other economic crises which cause emigration on a wholesale scale, and even when emigration is slow and steady. In this latter case the truth is not so easy to demonstrate statistically. Nevertheless, it is a fact that every country is increasing in population just as fast as its people can exploit their raw materials and develop their agriculture. In every land the people are pushing back the subsistence limit and raising the saturation-point as rapidly as possible. In their turn the difficulties inherent in the ordinary business of life press against the population, and hold the increase to a lower level than it would otherwise take. When there is relief from this pressure by war, by famine, or by emigration, therefore, it is but a momentary relief. The birth-rate rises and soon re-establishes the former state. For these reasons, permission for a few unfortunates from overpopulated countries to enter the United States does not solve the population problem of these countries. Italy has been sending us emigrants in wholesale quantities for a generation, yet the population pressure in Italy to-day is as great as it has ever been. Three hundred thousand more *bambinos* arrive every year than can be cared for properly. Emigration in this case is like dipping water out of an active spring; it flows in as fast as it is taken out, and maintains the level set by the pressure upon it.

2. *Conditions in this country are to-day, and will continue to be in the future, such that newcomers will meet increasingly bitter competition which must be accepted under unfamiliar conditions and often with linguistic handicaps.*

One often feels that the immigrant comes here with a very false impression as to the conditions he will meet. To

the European the country is, as was Canaan to the Israelites, a land flowing with milk and honey. It is a place where any one, with or without ability, with or without education, with or without skill, can obtain not only a competency but even riches. Earlier there was some truth in this idea. To-day it is a myth, an aged myth made presentable by the exaggeration with which it is rouged and powdered by returning visitors. The survival of the legend makes the immigration problem more acute by leaving a large part of the people of Europe with an unconquerable desire to become American citizens. This is unfortunate, not only because it results in individual hardship when the immigrant who actually arrives is disillusioned, but also because such disillusionment is the basis of the unvarnished nonsense on governmental reforms broadcast by the soap-box orator. We do not hear so much of this extreme sociological agitation to-day because we are in a period of prosperity, but when this wave recedes and the country is plunged into the next trough of unemployment and economic hardship, the sound will be heard again in increasing volume.

We are approaching a population problem in this country, though actual impact of population pressure on the country as a whole is still somewhat distant. One hundred and fifteen millions are fed by the product of about 500,000,000 acres of improved land, and the United States Department of Agriculture has estimated that the total acreage of arable land is upward of 800,000,000 acres; but since the remaining unoccupied land is not much more than half as productive as that which is tilled already, it is doubtful whether more than 700,000,000 acres are available in terms of present productiveness. Thus only about 40 per cent more people can be supported at the standard to which we are accustomed by current agricultural methods. A population beyond a hundred and sixty millions, therefore, can be fed only by increasing the efficiency of the farmer or by lowering the standard of living. Yet at the rate of increase hold-

ing sway during the last two decades, the tendency is to double the population in 44 years. In other words, the country is reaching towards a population of 214,000,000 in 1964. But the situation is really better than it appears from these statements. Careful estimates by our leading agriculturists show that it is humanly possible to support somewhere in the neighbourhood of 330,000,000 on the products of our soils without quite putting the people on the subsistence level of those of China or India; and Pearl has calculated, by fitting a curve to the population figures of the past, that a stationary condition will probably be reached in less than two centuries with a total approaching 200,000,000. Thus there are a few years of grace before the population question becomes acute. Nevertheless, we should not fold our hands with a sigh of relief because of this fact.

There is a point in the history of every nation¹ where the population is at an optimum. What is this point for the United States? Is it 100,000,000 or 300,000,000 or somewhere in between? The subway patron is inclined to think there are too many people in the United States to-day, and even the most phlegmatic person is tempted to shudder when he tries to imagine conditions where there are twice as many cities or cities twice as large; when he would meet two people in his daily life where now he meets but one; when, in fact, all the complexities and perplexities and trials of modern civilisation are increased and enlarged to double their present quantity. Other people take the opposite view. Adopting an attitude which they firmly believe to be religious, they endow God with their own delusions of grandeur, and believe He takes delight in the adoration of His children rather than in their happiness. In their idea there must be more people to worship God no matter what tribulations they undergo. Neither of these reactions is wholly just or reasonable. The most desirable popula-

¹ Cf. E. M. East. "The Menace of Overpopulation." *The World's Work*. June, 1925.

tion figure is one where distress and misery are at the ebb; where sunshine, good cheer, and happiness are at the flood. The optimum population of the United States is a population large enough for the protection of its borders and for the efficient production and distribution of the material comforts of life. It is one small enough to give every individual an opportunity to make living a real joy without a nerve-racking struggle for existence. It is one small enough to allow success to crown the efforts of preventive medicine in bringing about a lower disease-rate and a lower death-rate. It is one low enough to give every boy and girl all the education and preparation for life that they are capable of assimilating. It is one low enough that we may be able to retain our national parks and open spaces. It is one low enough to permit some leisure to cultivate science and arts. Now what is the magnitude at which these conditions can be attained?

In my belief this point is where the efforts of a nation begin to show diminishing returns, the point where the labour of an increased number of hands results in a smaller amount of goods for each. Every economist agrees that such a status is reached in all spheres of life sooner or later. Nations, like individuals, have a point of highest efficiency. They go up the hill, and pass down on the other side. If we can find this point and there keep the population stationary both in quantity and quality, we shall be saved from some of the horrors other countries have had to face. To calculate this altitude on the national barometer would unquestionably be the greatest service the science of economics could render, if the conclusions of its leaders were accepted and acted upon. It is a great task, and one is hardly justified in making a mere estimate. It may not be out of place, however, to call attention to the fact that agriculture is the basic industry, the keystone of the Nation's greatness. And the era of diminishing returns has already arrived in agriculture. The same statement holds true for forestry. One should

not be surprised, therefore, if the point where the breaking-down process begins is nearer than is apparent on the surface of things, even though it be admitted that increasing returns are still visible in many lines of activity. My own private opinion, speaking as one who has studied these matters as carefully as his capacity permits, is that *the optimum population figure for the United States is not far from 150,000,000*. It is more likely to be smaller than larger. In fact, Professor L. J. Reed, our foremost population mathematician, believes that we have already passed the optimum population point, because we have reached that place on the curve where population meets more depressing factors than accelerating factors.

So much for our national population problem in its crudest form. Whether our estimate of the most desirable level to which the Melting-Pot ought to be filled be somewhat under or somewhat over the mark does not matter so much as it does for us to realise that on a time basis the filling is sufficiently imminent to merit most serious consideration. Therefore it seems logical and reasonable to warn the prospective immigrant that he is going to meet a competition so keen that he is not likely to succeed in obtaining a place of any extreme desirability unless he has skill and ability above the ordinary. Furthermore, it seems only honest to admit that if we ask for immigration under these circumstances we are exploiters.

3. *Immigrants who come to us with lower standards of living tend to reduce our own standards.*

I made this statement in an address once upon a time, and the comment on it was as follows: "Immigrants have never lowered the standard of living, but they can reduce its cost by increasing production and adding to home markets." This is the type of reply made by editors of foreign-language newspapers who are so blinded by racial solidarity with the people from their native countries that they can see the justice of no single argument in favour of restric-

tion. But this is not the view of those Americans who have had to compete in an open market with unskilled labour. Any one who has watched the racial change in certain industries which are housed within the great cities of the East will have no illusions on the subject. Restaurants, barber-shops, small fruit and notion stores, and establishments for the furbishing of shoes, have passed successively into the hands of four different nationalities. Why? Because successively newcomers have arrived who will work longer hours themselves, who will expect longer hours of labour from each member of the family, who will evade the school laws more regularly, who will live because of long habit under more squalid conditions, and who will subsist upon more unappetising and less substantial rations than will families who have become somewhat Americanised. They save their money, however, and if they do not send all their savings to relatives in the homeland, in the second generation they have usually reached a higher social and economic level. Their children have obtained more education than their parents had, in spite of the difficulties. These children expect a higher standard of living and they get it; and when they have adopted this higher standard they must give way in their original occupation to the newcomers who can get along with less.

I do not say that there are no admirable qualities making up the urges which cause these immigrants thus to forge ahead. The industry and perseverance they show are very desirable. But I do say that competition with this type lowers the standard of living, the standard of education, and the standard of culture of those who must compete with it. This phase of the immigration problem is shown very clearly in the suppressed report to Governor Stevens on the Japanese problem submitted by the California State Board of Control. The Japanese were supplanting the American farmers, but not for the reason given by so many people in the East who knew nothing about it, and supposed that the

Japanese were better farmers and raised more food per acre. Actually they did raise a very small percentage more per acre than the American farmer, but their production per man-power was very much less. The American saved the health of his wife as much as he could and sent his children to school; he purchased magazines and newspapers; he endeavoured to build up a rural culture. The Japanese expected his wife and his children from the age of four years to work long hours in the fields, and to live under the cultural ideals of the peasantry of his country. Because of these things he could pay more rent than the American farmer. He could even buy the land at higher prices, and he was always able to find San Francisco lawyers who would evade the law and show him how he could buy it.

These matters adjust themselves. The standard of living of our aliens rises; it rises because of the influence and example of the culture already existing, built up by the Anglo-Saxon, who struggled hard to carve a civilisation out of the wilderness. Conversely, continuous contact with alien customs, which may perhaps be described least disagreeably by the word "primitive," acts as a drag on our own civilisation. Racially our Melting-Pot does not melt, but culturally it does; and if we mix low civilisations with high civilisations, the result is obvious. Let us make no mistake in this matter. Our more recent influx of prospective citizens did not bring us choice intellectual and æsthetic contributions from foreign lands to strengthen the weak spots of our own culture. A goodly portion of our importations have come from countries hardly more advanced than central Africa; and even those who came from countries ranking high in creative effort brought very few presents of this type with them, either actually or potentially. How many of the illiterate Neapolitans who came to us in such huge quantities during the first decade of the century were the scientific and artistic heirs of Galileo, Michelangelo, and Leonardo da Vinci?

4. *Immigrants who are relatively incompetent when compared with the native are expensive employees because of our tendency to think in terms of a minimum wage.*

There are many immigrants who are competent—as competent as the best of the native-born; but in the years just previous to the Great War the tendency to let in incompetents was increasingly in evidence. Employers demanded the labour of the unskilled worker, the man who could use the pick and shovel, the man who could furnish muscle, but whose brains, if any, were not required. It took capital to buy machinery; there was no investment in human life. If the machine wore out, it had to be repaired or replaced at great expense. If the man wore out, another was at hand to grasp his tools at no expense. But this was before the time and work of Mr. Taylor, the apostle of efficiency. When his studies were published and digested by the most progressive employers of labour, their ideas began to change. They began to see that these human machines required space in the factory and that space was costly. As machines they must produce enough to warrant their use of space, and by this criterion their value diminished. They made mistakes which no well-regulated steel machine would make; they caused accidents and breakdowns; they injured other workmen. So it gradually began to dawn on the American business man that unskilled labour at a low wage might be expensive. To complete his education, another gadfly appeared to annoy him. At about this time agitation to maintain the American standard of living at any cost became increasingly frequent. To accomplish this feat, in contravention of all economic theory, a minimum wage must be established in every industry sufficient to give every family some degree of comfort. Laws to this effect were placed on the statute-books in quite a large proportion of our States, though it was necessary to disguise them somewhat in order not to transgress the provisions of the Constitution.

The result of this campaign of printer's ink and oratory

was a change of heart among many of our capitalists. Their ethical standards mounted overnight. They no longer desired to play the rôle of philanthropist by giving jobs to incompetents under the plea that said incompetents were fellow human beings who ought to be supported, and that their wages, while necessarily low, were better than no wages at all. They realised that they had sinned in this regard. They demanded that they be allowed to pay high wages. All they asked in return was that the workmen employed should be *profitably* efficient.

Mr. Henry Ford, with the business acumen which he had always shown, was an early convert. At a time when the current wage for machinists was about \$3.50 per day he announced a standard wage of \$5.00 in his Detroit factory, and shouts of applause arose from among our amateur sociologists that here at last there was a capitalist who appreciated the worker. But Mr. Ford was not an altruist—he was a business man. Machinists vary tremendously in their skill. If the going price for machinists is \$5.00 per day, there will be machinists who are worth only \$2.00 a day, and there will be machinists who are worth \$8.00 a day. By this revolutionary economic scheme, therefore, Mr. Ford obtained five million dollars' worth of free advertising, and at the end of 18 months had hired and fired enough machinists to fill his factory with workmen who were worth the \$8.00 a day. Mr. Ford's sapience and his psychology seem very obvious, but apparently the press of the country, and in particular our amateur sociologists, made no such obvious deductions as to the cause of his activities. They pictured him as the guardian angel of the working man, and called down the wrath of Heaven on every employer who did not follow his example forthwith.

But, one must ask, who is to take care of the labourers who, under these standards, are worth only \$2.00 per day? We have these incompetents, many of them, native as well as immigrant; and in the pre-war days we were getting in-

creasing numbers of them from foreign shores, for the impelling cause of immigration had changed during the past half-century. Immigrants were no longer thoughtful political and religious radicals taking refuge here because their ideas were in advance of their time, or adventurous men, full of energy, whose powers could not be fully developed in their homeland. In an increasing percentage they were people forced out of their native land by economic pressure, squeezed out, one might say, by the Malthusian law. They came because they could not make a living in competition with the best of their own race.

5. *Incompetent immigrants are expensive fellow citizens because they add to the tax rates; that is to say, they require more than a fair share of the public money to be spent for their education, protection, and care.*

As evidence on this point, one may refer to the intelligence ratings in the Army tests¹ of 1917 and 1918. About 12.0 per cent of the total white draft was rated *A* or *B*, while 13.2 per cent of the native-born white draft showed the same superior intelligence. Natives of England, Scotland, and Holland were the only foreign-born drafted men who were above the average, the percentages of *A* and *B* men for these countries being 19.0, 13.1, and 12.4 respectively. In contrast to these figures were the following percentages: for Ireland, 4.3; for Austria, 4.1; for Russia, 3.3; for Greece, 2.2; for Italy, 1.5; for Poland, 1.1. And these countries are the ones from which we were getting an increasing number of immigrants each year.

The reverse of the picture is as follows. The percentage of the total white draft rated *D* or *E* was 24.1, the percentage of the native-born white draft in the same group being 21.0. Of the foreign-born, the natives of Denmark, Germany, Scotland, Holland, and England had a smaller number of *D*'s and *E*'s, the percentage for England being 8.8. The

¹ R. M. Yerkes, ed., "Psychological Examining in the United States Army." *Mem. Nat. Acad. Sci.*, vol. 15, 1921.

foreign-born having the highest proportion of *D* and *E* men were: Greece, 44.6; Russia, 55.7; Italy, 60.5; and Poland, 63.8.

Whatever opinion one may hold as to the precise meaning of the psychological tests from which these ratings were made in terms of innate intelligence, one fact cannot be ignored. Almost without exception the *D* and *E* men were slow and unteachable. They seldom attained sufficient skill at their tasks to warrant promotion to even the lowest rank of non-commissioned officers. The men who became proficient at soldiering were the *A* and *B* men. Which type is likely to become the leader in the battle of life? Which type will give an adequate return on the money which the tax-paying public expends in education?

In the testimony of H. H. Laughlin of the Eugenics Record Office before the Congressional Committee on Immigration of the 68th Congress, and published under the title "Europe as an Emigrant-Exporting Continent and the United States as an Immigrant-Receiving Nation," there is additional evidence of the high cost of present-day immigration. A survey of 210,835 inmates of 445 benevolent and penal institutions was made and analysed statistically in various ways. A few of the more significant results are as follows:

If the white population is taken as standard, then the percentage of feeble-minded found in institutions in proportion to the percentage expected is: native white of native parents, 97.9; native white, one parent native-born, the other foreign-born, 173.0; native white, both parents foreign-born, 150.4; foreign-born, 29.0. That is to say, our examinations at ports of entry reject a considerable portion of the feeble-minded who would otherwise enter; but proportionately one and one-half times as many producers of feeble-mindedness have been admitted than were here already.

Institutional commitments for insanity on the basis of total population over 20 years of age are: native white of

native parents, 79.0; native white, one parent native-born, one foreign-born, 130.5; native white, both parents foreign-born, 135.3; foreign-born, 146.9.

Institutional quota fulfilments for crime based on the white population over 20 years of age are: native white of native parents, 83.4; native white, one parent native-born, one foreign-born, 132.9; native white, both parents foreign-born, 88.4; foreign-born, 65.4. The showing here is relatively good when accepted without further analysis. In a more detailed study of 155 State and Federal custodial institutions made by Laughlin, however, it is shown that quota fulfilments by natives of Switzerland, Ireland, Germany, Scandinavia, and Great Britain are all under 50 per cent, while Italy shows 218, Turkey, 240, Greece, 293, West Indies, 318, China, 337, Bulgaria, 366, Mexico, 549, Spain, 660, and Serbia, 1400 per cent.

6. *Large numbers of foreign-born lead to a foreign policy based on expediency rather than on sound principles, because there are numerous groups to placate.*

On this point a volume entitled *Race or Nation*,¹ by Gino Speranza, an American-born Italian educated in the Law, is to be recommended. I know of no other work which presents so forcibly and brilliantly the effect of enormous numbers of aliens from different countries on our political life.

Few people not professional statisticians realise what a varied collection of individuals make up the population of the United States. In 1920, when the total population was 106,000,000, there were over 10,000,000 negroes, and about 11,000,000 belonging to the black, yellow, and red races combined, leaving a white population of 95,000,000. Of the latter, nearly 14,000,000 were foreign-born, and nearly 23,000,000 were children of parents at least one of whom was foreign-born, thus making a total of nearly 37,000,000 whose lives had been more largely influenced by foreign

¹ Gino Speranza. *Race or Nation*. Indianapolis. Bobbs, Merrill, 1925. Quoted by permission.

traditions than by the traditions of the United States. But census figures of first and second generation aliens cannot of themselves give a clear idea of the effect such masses have on governmental policies. Let us consider some more concrete illustrations.

Most of us remember what power in behalf of the Empire our citizens of German descent exercised on public sentiment during the years from 1914 to 1917. Similarly, citizens whose immediate ancestors came from the Allied countries, to a man, threw their strength with the cause of the Allies. I do not criticise either reaction. I even take the opportunity to pay a tribute to our citizens of German origin who did their duty so wonderfully after the declaration of war, sad at heart though they were. I merely wish to point out that these two uniform responses in opposite directions are not evidence of independent, unbiassed, logical judgments. Yet the influential Americans with German names have quite a different status from those whose homelands are in southwestern and eastern Europe. In most cases both parents and all four grandparents were born here. Furthermore, they came from people whose education, and hence whose manner of thinking, is very similar to those of Anglo-Saxon descent. Even alien Germans learn English quite readily, read American journals and newspapers, and find themselves quite at home in the United States.

This is not true of the New Stock citizens. They support over 1,000 newspapers and magazines published in 30 different languages, from Arabic to Welsh. They are united by social ties into groups of various sizes in which foreign languages are used almost exclusively as the means of intercourse. The last United States religious census, which is rather fragmentary, lists 202 different denominations of which 132 report that a part or all of their organisations use foreign languages. They group themselves together in society, in religion, and in business; and the natural result

is that they become increasingly race-conscious. They are more Poles and Italians in this country than they are in Poland and Italy.

I have recently had occasion to look over the files of a number of foreign-language newspapers. It is not only in their language that they are foreign; they are foreign in their psychology, in their ideals, in their points of view. Practically nothing is done to Americanise the reader. Their problems are the problems of the countries from which they came. In the New England mill towns the problems are French, in other places Italian, or Polish, or Lithuanian, or what-not. Mr. Speranza ought to know something of the feeling of people of his own race. He makes the following statement: "Carol Aronovici, an intellectual leader of his people and a former official of the State of California, has frankly said before the American Academy of Political Science: 'The loyalty of the Poles, the Russians, the Greeks, etc., in some measure will be determined by the international policies of the United States.'"

One sees clearly from these foreign-language papers what country is their real *patria*. One cannot confer American conceptions like a college degree after 60 months of residence. The epithet "bigamists in citizenship" which the editor of an anarchist weekly applied to some of our newer citizens is clearly appropriate. Furthermore, they know their power and use that power very largely for non-American ends. Various racial groups openly boast of their political influence. They threaten with oblivion statesmen who are thought to be independently American. Since we have few statesmen, and are mainly ruled by politicians who keep their ear to the ground for their own advancement, the Polish vote, the Jewish vote, the Irish vote, and the Russian vote must be reckoned with. Listen to what the author of *Race or Nation* gives as his mature conclusions:

Now let me add that in my youth I hoped for the possibility of the absorption of racial heritages under the assimilative process of American

democratic forces; not a "synthetic" Americanism, but the original spirit and genius of your race nourished, as it were, but unchanged, by new and fresh blood. Long study, observation, and thought have wholly changed my views. The effect of mass, for instance, in the immigration of the last 50 years especially, is such as to overcome the natural assimilative forces of even a younger and less distinctly defined society than the United States. Then it has become more and more clear to me that racial characteristics do not die out, especially those subtler qualities of mind and character which profoundly differentiate the culture and the spirit of one people from those of another. These racial characteristics are transmitted from generation to generation practically unchanged; though they may lie dormant for long periods or lives, or manifest themselves obscurely or only under the stress of a conflict of racial ideals. Add to this the almost abysmal ethnic, cultural, and historic differences from the American stock in some of the elements of the newer immigration; consider that the easy and rapid means of international communication to-day powerfully tend to keep the alien under the influence of his original civilisation, and the conclusion seems unavoidable that the possibility of even an approximation to real national absorption is practically nullified.

That all this is coming to be more and more recognised can hardly be challenged. It is evidenced, on the one hand, by an increasing unrest in certain parts of the land and a growing demand for more drastic restrictive and protective measures. It is evidenced, on the other hand, by a tendency in certain New-Stock "intellectuals," aided and abetted by "internationally minded" Americans, to theorise about a future amalgamated or mongrelised Americanism. Some of these look forward with satisfaction to a "Synthetic America" or a federated United States composed of racial groups living side by side as the English and French in Canada. Others among them actually exult at the thought that "each of the races that we now know on this soil" (and that writer includes the yellow and brown races) "will have its share of ancestral responsibility for the typical American now in the making."

7. Large groups of foreign-born prevent us from developing a unified national culture.

We do not want a uniform national culture—there is no question of endeavouring to promote such an eventuality. The ideal would be the best from every type of civilisation; but these "bests" must be blended and cast into a unified whole. This is what cannot be done under mass immigra-

tion where the groups which enter organise themselves as units and erect a bulwark between their own culture and that which they meet over here. It has been demonstrated beyond a doubt that the liberal-mindedness, the fairness which has made the Anglo-Saxon capable of governing himself, is a cultural heritage which is foreign to many of our local groups. Their legal traditions are different, their religious training is distinct, their moral outlook is far removed from our own. I do not maintain that they are lower—merely that they are not the same, and that it is practically impossible to sift out the good of each and to blend it in with our own when there is no possibility for the stirring and mixing process from which a blend must come. Lumps of undigested foreign material must remain lumps of undigested foreign material for generations under such circumstances.

8. *Immigrant competition tends to sterilise the native population.*

Many of our immigration critics find such a statement to be very mysterious. It would not be mysterious if they would study the birth-rates and death-rates of the various racial stocks when put into competition with each other. The immigrants of the New Stock are usually very efficient at reproduction. Their birth-rate is high, and if left to themselves their death-rate would be high; but the humanitarian efforts of those who have been in this country longer aid them to lower this death-rate. In the next generation the birth-rate declines; so also does the death-rate. When one compares the rate of natural increase of population of the various racial groups of the same general economic status he finds that there is a very close correlation between the length of time in this country and the crude birth-rate. Ambition is aroused, desire for a higher standard of living is born, when the immigrant comes in contact with those who have had more opportunity and who have made the most of their opportunity. And to give their children more,

the patrimony must be divided into a smaller number of portions. A social competition is therefore built up. Yet where there is no such competition, as in our rural districts in which 80 per cent of the stock is native of north European origin, the birth-rate continues high. From studies of this type, therefore, our population statisticians come to the conclusion that immigration does not increase the population of a nation. People who come in as adults fill the places that would have been filled by children of the native stock had the niches not been usurped by the foreign-born. Prescott L. Hall, one of our best students of immigration, says: "Nearly all students of the matter are agreed that the United States would have a larger population to-day if there had been no immigration since 1820." This thesis has been attributed to General Francis Walker, superintendent of our census of 1870 and 1880. In one of his papers he says: "Foreign immigration into this country has, from the time it first assumed large proportions, amounted not to a reinforcement of our population but to a replacement of native by foreign stock; that if the foreigner had not come the native element would long since have filled the place usurped, I entertain not a doubt." Walker was not the first scholar to enunciate this conclusion clearly and unequivocally, however. In the writings of the first civilised American, Benjamin Franklin, we find these sentences written over a century before Walker's time:

The importation of foreigners into a country that has as many inhabitants as the present employment and provisions for subsistence will bear will be in the end no increase of people. . . . Nor is it necessary to bring in foreigners to fill up any occasional vacancy in a country; for such a vacancy (if the laws are good) will soon be filled by natural generation.

9. Immigration when forced by economic necessity tends to lower the biological quality of the race.

In the long run it seems to me that this last result of immigration, the genetic result, is the most important of all, and is least likely to be considered either by proponents or

opponents. We are usually interested in immediate causes and immediate effects. The immediate results of immigration are usually economic but the end results are biological. Let us see why.

All nations and races show an extremely high variability in the inherent ability which they exhibit. Nations and races may differ in their average levels also, but this does not need to concern us here. The important thing is that all along the great stretch of hereditary differences which distinguishes the highest grade, that one may call genius, from the lowest grade, that one may call feeble-minded, are found the nationals of every country. Generally speaking, the mediocrities are the most numerous, and as one passes to the extremes of the curve on either side the proportion becomes lower and lower.

Roughly, in this country to-day about 25 per cent of the people may justly be called undesirables in the sense that they do not have the capacity to deal with modern complex conditions, and must be aided directly or indirectly by those who do have this capacity. Graded on the same scale certain other countries show a still higher proportion of these groups.

It is merely a cold fact, therefore, that an immigration which comes largely from this group lowers the quality of the nation to which these individuals come. And when such immigrants have a greater fertility than the native population, which is also a fact, the consequences are disastrous.

Earlier, the immigration to this country was representative of the emigrating race. At times it was even a selected quality, as in the numerous instances where high-spirited independent thinkers came here because forced out by the religious or political bigotry of a necessarily mediocre majority.

But what happens to-day? We do not get so many of these high-grade brains. We get some from every nation;

and they are, or ought to be, very welcome. We need them. They will raise the average. We do not get so very many of the lowest grade. Our laws have long taken care of that about as well as legal measures can take care of such a matter. But the psychological records do show that by far the great majority of the newcomers to the United States within recent years grade lower than the average already on the soil. The quality of the race is being lowered by their admission.

And what else could be expected? The one great reason for the current emigration from Europe, from whence nearly all our immigrants come, is because overpopulation has made the struggle hard, because only the fittest can succeed and remain there in more or less comfort; the remainder must emigrate or must remain as the submerged fraction of the populace. Except in rare cases, it is not the geniuses or even the superiors who come to us for refuge. It is the inferiors who are forced out by economic pressure. If we take them, neither their descendants nor our descendants can have a fair chance when this same type of struggle comes to this country in the not far distant future. It is a serious matter.

The trouble with immigration as a problem for the American people is that this same American people does not take the trouble to learn anything about it. America is not made up of hard-headed grasping capitalists or of soft-headed sobbing sentimentalists, but it is made up of people the vast majority of whom take no interest in those sociological, political, and economic problems that must be solved, and solved correctly if the nation is to show continued success and progress.

I venture to say that nine-tenths of our citizens see prospective immigrants only as a lot of ambitious, hard-working people anxious to come to America to make their way. They say to themselves: "Let us take in as many of them as we can without hurting our opportunities, or affecting our

pocketbooks—disadvantageously.” And those who believe they see a little farther than the rest remark cunningly: “We mustn’t keep out the Pupins and the Santayanas who have done so much for the country.” One may grant the desirability of the Pupins and the Santayanas, yet it ought not to be difficult to see that the immigration of the past 50 years has produced far too few of them. Several statistical studies of eminent men in America show that they are still coming almost exclusively from the Old Stocks. New Stocks names are virtually absent. It seems pertinent, therefore, to ask: “How many great men from among the Old Stocks were prevented from being born by the admission of 10,000,000 of the New Stocks?” Furthermore, let us not delude ourselves into believing that the prospective latter-day immigrants are a lot of selected individuals from the various countries of Europe bursting with ambition to come to America and make good. On the contrary, they are in far too great a proportion the least intelligent of their nations who do not come here of their own initiative, but are inveigled here by the roseate-hued propaganda of steamship companies and other agencies which go at their business in the same way as the promoters of wildcat mining companies.

Over 60 per cent of the recent immigration to this country are, as Safford says, “defective or inferior types incapable of looking out for their own interests and conscious of their own inferiority, always ready to follow the demagogue who flatters them by blaming the social order, the form of government, the political party in power, or somebody or something for the consequences of their own defectiveness and inferiority. And entirely apart from this matter of individual capabilities we see coming into this country a constant stream of representatives of nations, of people, and even of civilisations, whose history is very different from the history of the people who determined the present form and character of government of the United States.”

Safford's experience drove him to the further conclusion that a goodly proportion of those immigrants who are above the average in intelligence do not come to America to take a sympathetic part in its development: they come to exploit it, for what they can get out of it. To them an American is a fool and his government a joke, and this contemptuous opinion is confirmed by the ease with which their politically organised compatriots can set our Congressmen running around Washington in a furious endeavour to secure the admission of people who have been denied an entry by those regularly authorised to administer the law.

If one wishes to confirm this conclusion, it is not necessary to attend a Bolshevik meeting, Safford remarks; all he needs to do is to rub elbows with the second-cabin passengers of an incoming ship and listen to their conversation. There he will hear Scandinavian, Englishman, Hollander, German, and Jew, some of whom are already deriving their living from America, expressing their scorn of the country in no uncertain terms. And this supercilious disparagement, unfortunately, is merely an echo of voices from all over Europe where there has ever been reluctance to concede to this country the right to regulate its own citizenship. We think that our right to enact legislation regarding immigration is axiomatic; but only two countries, Great Britain and Germany, have made a formal acknowledgment of the contention by treaty. Italy even has the impertinence to speak of "our" colonies in North America and to demand dual citizenship.¹

Of course a good deal of the talk one hears from immigrants, or our foreign-born residents, may represent merely senseless faultfinding or indicate the recognition of conditions which we ourselves know are not what they ought to be, but back of it all there is a deep-seated, honest conviction on the part of many people who come here that America, its Government, its institutions, and the administration of its laws are wrong. This attitude may not be incompatible with the slow development of

¹ See Safford, *l. c.*, p. 50.

sincere patriotism on the part of foreigners who have come here and have really made this country their own, even those who may have come here after adult life, but the trouble is that comparatively few peoples in the world have shown any inherent capacity for practical self-government such as our constitution contemplates. The Continental European may theorise glibly about democracy or socialism, but he is always looking for some governmental authority to manage his life and his affairs. Americanisation is not going to make much progress with people who can develop no confidence in American institutions, whether inability to do so be the result of previous training or be due to inherent racial mental characteristics, and whether such people be distrustful of democracies in general or believe the very principles of our Government to be "based on obsolete eighteenth-century ideas."

CHAPTER XV

THE PROBLEMS OF EVERY-DAY LIFE

THE chief purpose of this book has been to block in roughly the shadowy background of genetic philosophy which underlies so many of the problems of human society, rather than to advocate specific social policies. In so far as there has been a single thesis, it is this: society is a huge colonial aggregate, composed of units having diverse values; these units wear out and must be replaced; consequently the kind of material used in the new parts makes a great difference in the smoothness with which the organism functions.

One of the most distinguished thinkers¹ of the present day, after pointing out that society is decaying, as it has often decayed before, from loss of religious faith, unwholesome use of material power, and a differential birth-rate favouring the lower orders of humanity, comes to the hopeful conclusion that mankind will win the game in the end if the evolution of the superorganism is controlled. "The problem," he says, "is not how to produce great men, but how to produce great societies. The great societies will put up the men for the occasion." It seems to me that there is a sadly inverted logic here. Plato had a clearer vision nearly twenty-three centuries ago when he said: "The best of each sex should be united as often as possible, and inferior with inferior; and they are to rear the offspring of the one sort but not that of the other; for this is the only way of keeping the flock in prime condition." It is a little difficult to produce a co-ordinated whole without thus paying attention to the component members. Given the great men, society will advance; without them, it will rust away.

¹ A. N. Whitehead. *Science and the Modern World*. New York, Macmillan, 1926.

Doubtless the geneticist is a Utopian in his leisure moments. Most men are. Yet he visualises no ideal state, no crystallised *Republic*, incapable of evolution. His fine frenzy conceives merely a potent creative power, that power intelligence. Given this, he believes the rest will follow. The philosopher-king of Israel required as much. "Wisdom is the principal thing; therefore get wisdom: and with all thy getting get understanding. Exalt her and she shall promote thee: she shall bring thee to honour when thou dost embrace her. Her ways are ways of pleasantness, and all her paths are peace." So did Socrates, for whom ethical ideals were ideals of rationalism. So did Aristotle, whose best conceivable government was an aristocracy of those equipped to govern. So did Bacon, whose *New Atlantis* was a structure founded on science. Where the geneticist is bolder than the rest is in offering some insight into the ways and means of preserving and enhancing intelligence, of preventing stupidity. He would extend Bacon's categories of ambition to a further grade. The most vulgar ambition, writes the most eloquent of philosophers, is the desire to extend private power; somewhat more worthy but not devoid of avarice is the ambition to enlarge the influence of one's country; but the noblest aspiration is that of helping the human race to dominate nature. The twentieth century has given us a still higher ideal—man directing his own evolution with the view of securing a continuous supply of human material capable of coping with the entangled problems of life.

In 300 years mankind has gone a considerable distance towards realising the essentials of the *New Atlantis*. No scientists have been enthroned, as Bacon hoped. Instead, conservative mediocrities are elected to chairs of authority, that their mental inertia may act as a governor on the political machinery of the state, and prevent it from changing its course too suddenly. But for all that, science rules. Our lives are regulated by Newton, Faraday, Pasteur, and the

other saints of science, rather than by those who wield the rods of empire. The only trouble is, we wait overly long before we canonise them and adopt them as our patrons.

Yet it is probably wiser not to try to change abruptly this system of slow and orderly advance. As F. C. S. Schiller,¹ the brilliant English philosopher, has remarked, Utopias are too hard and fixed, too revolutionary. Social doctrines must be elastic, adjustable to new knowledge. Moreover, they must not postulate a human nature incompatible with the facts. Man is not a member of the angelic host. He is at best a rational animal, and one cannot always rely on the modifying adjective as being distinctly descriptive. His reasoning power is a recent product, his animalism is ancient and firmly established. The student of heredity may well content himself, therefore, with directing attention to those little problems of every-day life which genetic knowledge may help one to understand, leaving others to pen idealistic constitutions. Who knows but that his hopes for social progress will come as near to realisation at the end of three centuries as did those of the omniscient Chancellor of Queen Elizabeth?

We have already described the more important hereditary traits and how they are transmitted, how even a particular disease may run its course in diverse ways owing to the various constitutions which different individuals possess. We have shown how racial immunity is acquired, and why natural immunity is unnecessary after a specific parasite has been suppressed. We have traced the consequences of various systems of human mating, of selective birth-rates, of selective death-rates. We have discussed the inheritance of intelligence and the relative responsibility thus brought about. We have emphasised the distinctive rôles of heredity and environment. To recapitulate under these headings seems unnecessary. They are all questions of the day,

¹ F. C. S. Schiller. *Eugenics and Politics*. Boston, Houghton, Mifflin, 1926.

to be sure; but there are other questions wherein genetic consequences are less obtrusive which should be mentioned.

Let us first examine the current system of polity in the United States. The major premises of government are included in the one catchword "democracy." From this single biological postulate all policies appear to flow. One may protest that no biological significance was attached to the term by the members of the Continental Congress, and that no reasonable man of the twentieth century could honestly load it with such a meaning. Doubtless this is true. Yet the open confession of faith of radical social reformers contains the following tenets, which are only mildly objected to by more conservative souls: all races and all individuals within each race are potentially equal, environment is all-powerful, and acquired characters are inherited as specifically and directly as any other characters. These tenets are genetical—biological. They do not happen to be true; but this is no deterrent. To those with the will to believe, they are axiomatic and need no proof; though any statement by a professional scientist supporting them is eagerly applauded, even when the writer has no knowledge whatever on that phase of science given over to their investigation. The enthusiasm with which the staccato pronouncements of Doctor George A. Dorsey have been received is a case in point. It is unnecessary to inquire into the reasons for this peculiar psychology. The essential matter is that in actual practice these doctrines are followed.

The Army tests showed that 25 per cent of the adult population of the United States is unable "to read and understand newspapers and write letters home." It would be a relief to attribute this condition to lack of opportunity, and for some, such an explanation will serve; but the proportion is not so high as one might expect. No conspicuous lack of opportunity to obtain a grammar-school education exists. Reasonably adequate elementary schools have been provided throughout the country, and the laws of nearly every

State compel attendance for a period sufficient to take the average child through the grades. These people ranked low in literacy simply because they were unable to learn. On the basis of intelligence returns from the draft, judges whose qualifications make their opinions worthy of respect have estimated that 25 per cent of the population are inherently unqualified to pass beyond the elementary school, that 40 per cent cannot finish the grammar-school, that 60 per cent cannot perform high-school work satisfactorily, and that 80 per cent cannot carry out work of college grade.

Popular government under such conditions is built upon a singularly unsound foundation. Suffrage is exercised by every individual above the grade of imbecile who has accomplished 21 years of mundane existence. Political power is denied to a handful of defectives of institutional grade, and to some 3,000,000 negroes—the latter ostensibly because of illiteracy and lack of property. The remaining adults go to the polls, elect representatives to various offices, participate in initiative legislation, settle referenda, and decide recalls. Some 30,000,000 people, in theory at least, are given entire charge of this country with its tremendously intricate problems, and the maximum requirement for the job is the ability to read by rote a few sentences of the Constitution.

Thus our whole governmental system is out of harmony with genetic common sense. Would it not be better to revise it, to revise it radically in a direction 180 degrees removed from that which our radicals advise? Is there any reason whatever to suppose that the country would not be better off if suffrage depended upon an educational qualification at least as high as that which our best high schools demand in their entrance examinations? Certainly imbibition of these few grains of knowledge may be taken as the minimum preparation necessary for solving current social and economic enigmas. I would go even further and suggest experimenting with the plural vote, with higher qualifications as prerequisites. Other countries have tried it and

have found it satisfactory. Lack of familiarity ought not to cause us to dismiss it with no consideration.

Undemocratic? Nonsense! The scheme need not be undemocratic. Let every child, without regard to its race, colour, or economic station, receive all the education it is capable of assimilating at the expense of the State. Provide educational facilities of all kinds—Latin schools, English schools, business schools, trade schools, technical schools, colleges and universities; and give every citizen of the republic the opportunity to develop all the ability he possesses. Then extend or curtail the franchise in accordance with the outcome of the probationary test. Plural voting privileges for those who make good, provided all have equal opportunities, might be the height of wisdom; but apart from this heretical suggestion, the plan has the merit of being just, reasonable, and truly democratic. It is said that the scientist fails to receive support for his practical social policies because he is all head and no heart, that Bryanism is popular because the Commoner was all heart and no head. Here we combine the two.

It is difficult to see how the quality of the electorate can be raised except by the adoption of some such scheme; and if the quality does not go up, there is little possibility of making the actual business of government efficient and sensible. To-day only about 15 per cent of the public servants inducted into office by the will of the people are qualified for their positions. Tested by character, education, and experience, the manner in which the personnel department of every great business tests applicants for employment, 5 out of 6 would be rejected. The resulting activities of this poor sample of the population are naturally unsatisfactory. Whether it is a miracle that they are not worse, or only because they are watched by a coterie of intelligent and forceful men, I am unable to say. At all events, our worthy electorate is dissatisfied and is continually asking for increased powers, which makes the situation doubly ridiculous. Voters

who have not had discernment enough to elect trained, effective men to the offices within their gift wish to have more intricate matters left to their tender mercies. And they get what they demand. They elect senators, they become legislators by petition and by referendum, they fire those whom they previously hired. The latest request, now in process of being granted in various States, brings about a change in the only branch of the government which functions rather decently, the judiciary. One can hardly doubt that the innovation is for the worse. Our executives have usually obtained expert advice from bar associations and elsewhere concerning prospective appointments to judgeships. To turn the matter over to the ballot-casters of the commonwealth is not likely to be an improvement.

The thaumaturgists, by the magic of the word "democracy," have brought about other changes which interest the geneticist. The current trend of governmental policy, in most of the European countries as well as in the United States, is towards a queer mixture of socialism and paternalism. The socialism takes the form of a sliding scale of taxes, bearing most heavily on those having the greatest wealth. The proceeds of this system, beyond the waste and the overhead, are spent presumably for the benefit of all. In part they go to finance schools, clinics, hospitals, sanatoria, libraries, parks, art galleries, and a hundred other institutions which, a century or so ago, were not considered proper benefices for the people at large. The paternalism takes the form of making the world safe for the feebly inhibited by legal enactment.

The motives behind these endeavours are praiseworthy. As Wiggam¹ says, the milk of human kindness fairly oozes from our pores. To better conditions, to make life more worth living, we are willing, at a moment's notice, to devote any amount of money to the relief of the homeless, the

¹ A. E. Wiggam. *The New Decalogue of Science*. Indianapolis, Bobbs, Merrill, 1923.

fatherless, and the distressed. We mean to be the poor man's friend. "I am never concerned with what is in your heart," he writes, "but what is in your head. You would like to do well. But hell is paved with similar pious intentions." Let us consider whether these efforts to apply the Golden Rule are properly safeguarded; for the author of *The New Decalogue of Science* is right in saying that if they are not, they will wreck the race that tries them.

Where shall we begin? With feminism, perhaps, for few social movements affect the next generation in such subtle ways. Political equality between men and women has come to be an accepted doctrine during this last generation. Most of us remember with what zeal the early protagonists were wont to debate the matter. More often than not they disdained to use the one unanswerable argument in favour of votes for women—its justice. They had higher claims. It would purify politics, it would promote just laws, it would bring into operation a new humanitarianism. None of these hopes has been fulfilled, or is likely to be. Yet political equality has been the point of departure for a broad movement which now bids fair to effect marked alterations in the structure of society. Women demand modification of marriage and divorce laws, and of other laws which concern domestic relations; they decree a single standard of sexual morality; they request economic equality, and—inconsistently—minimum wages and subsidies.

Some of these requisitions will be honoured without further appeal. New customs will simply grow upon us. Others, especially where an effort is made to nullify economic law by legislative enactment, need consideration. Equivalent remuneration for a given type of work seems equitable. Minimum wage claims sound plausible. Endowment of motherhood appears reasonable. Tested alone in the scales of the blind goddess, perhaps they are just. But the trouble is, these questions cannot be judged singly and apart. Their ramifications are extensive; they impinge on all sorts of

seemingly unrelated matters. Our concern here is whether they have an effect on preferential mating, on age at marriage, on the differential birth-rate; and obviously they do. Decision should not be made, therefore, until all the facts are weighed. If this be done, and the good points of a given measure still seem to predominate over the bad points, perhaps a wise method of modifying the proposal can be found which will minimise its disadvantages. After all, most practical schemes are compromises.

What one has to consider in this connection is whether any real economic equality between men and women is compatible with family life and children. How far will the ever-increasing employment of women in commercial pursuits raise the age at which they marry and thus reduce the birth-rate? It may be desirable to view a generally diminishing birth-rate with equanimity because of the rising density of population. Even so, it becomes important to know whether the more capable women are delaying or foregoing motherhood in greater proportion than the less capable. Is equal pay for equal work a good thing because it tends to increase production, or is it a bad thing because it tends to keep women employed permanently? Is there any sound argument in favour of artificial wage standards? It has even been claimed that minimum-wage laws for women are eugenic because they keep people of low capacity at work, and therefore reduce the number of offspring. The feminist argument for subsidised motherhood is this: the state is benefited when woman marries and bears children, and therefore ought to pay her what she would have received had she not abandoned her economic independence. This argument is gaining many supporters for the movement. The other side questions the effect of such revolutionary procedure on the new generation. The stupid, lazy woman, they say, cannot make much of a career for herself, and would care nothing for it if she could. She will barter her freedom to the first comer for the safe haven of a home,

without counting up the further possible cost to herself. A probable annual succession of babies is a wholly unforeseen contingent. The capable, ambitious woman, on the other hand, will think twice or even three times before exchanging her independence for such a doubtful return. Thus the differential birth-rate is advanced to still greater proportions.

Feminists and antifeminists, both male and female, are making another strenuous campaign side by side. Advanced humanitarianism, which is not always advanced thought, is rallying to save the mothers and babies.

Obstetrical societies are making intensive efforts to improve their art, and to secure hospital facilities in the small towns equivalent to those found in the great cities. This branch of medicine and surgery has found how to deal with puerperal infections. It has made instrumental deliveries, when carried out by properly trained surgeons, as safe as normal births. Hemophiliacs no longer need fear childbirth; their blood can be forced to clot by the use of sheep serum. Cæsarean sections are commonplace, and are accomplished without destroying the newcomer with too much ether.

In another department the doctors of public health and the social workers are co-operating to reduce infant mortality. Prenatal clinics are being opened where expectant mothers are taught the hygiene of pregnancy. Additional visiting nurses are being procured. Certified-milk stations are being opened where modified cow's milk of high grade is sold at or below cost. The Children's Bureau and other organisations are studying the environmental factors which influence the infant death-rate. They find that it goes up when the homes are squalid, when the mothers are stupid, when the fathers have low incomes, when the birth-rate is too high, when the babies arrive at too short intervals, when the mothers are required to work too hard; when, in fact, low intelligence and economic stress are linked together like the Siamese twins.

And what is suggested for the future? More free clinics. More public hospitals. Renovation of the slums. Higher wages. Unemployment insurance. Maternal subsidies. Bounties for babies.

Superficially, both the present activities and the proposed programme seem very commendable. They satisfy our sympathies, our urge to do for others as we would have others do for us. But every suggestion as it stands is unsound biologically. Each nullifies natural elimination of the unfit. Physically defective women are encouraged to become mothers. Weak infants are carried through babyhood. Incapable men are persuaded to transmit their lack of ability regularly and often. Improvident persons are suborned to further lack of foresight. A new baby is made to appear an economic asset to those without much capacity for reasoning.

England has tried non-contributory employment insurance. It merely promoted pauperism. France and Germany have experimented with subsidies to enable prospective mothers to rest before and after confinement, and several governments have essayed to give monetary returns for childbearing. The results have been disillusioning. They have been surprisingly like those obtained in the Massachusetts antify campaign, where every bright boy bred *Musca domestica* in quantity to obtain the bonus offered.

I hope the reader will not draw erroneous conclusions from these statements. The biologist is not a hard-hearted, ruthless soul. Nothing would please him better than to lend a hand in this work of social reconstruction. He would be only too willing to submit to any reasonable taxation, and in addition to give of his time freely in order to further schemes for relieving the downtrodden and helpless, provided the plans be safeguarded in such a way that they will not create more misery than they alleviate. It is not easy for him to forget why benevolence is needed. He has compiled too many pedigrees of socially inadequate families

whose incompetent members have received charity from himself and his ancestors for generation after generation. The biologist therefore demands cures instead of first-aid measures. The cure, in so far as a single remedy will save, is birth-control. There is no other corrective. Until birth-control is recognised as a necessary social prophylactic by public-health officials and family welfare organisations, this well-intentioned philanthropy and social service is nothing but a brutal gesture to posterity. These admirable plans will only work if the people who are helped are taught to show some regard for society as well as for themselves by controlling reproduction so as to promote the health and general welfare of both mother and offspring.

Moreover, this type of service cannot continue indefinitely if those who require it devote themselves to unrestricted propagation of their kind. The true worth of a man, our economists say, is the value of his services minus his consumption; and a just society would see that he is paid a full return. If this be true, we should hope for something less than justice. It would be nothing less than obscene to have the poet, the composer, or the scientist acquire the wealth which now goes to the prize-fighter. But our Marxian friends should be sensible enough to realise that strict justice would require a much more unequal distribution of goods than obtains at present. The productive ability of fully one-fourth of the adult male population is below its consumption. The benevolent and corrective institutions, which now require a total of nearly one-fourth of all taxes and one-sixteenth of all earnings, are carried on with the surplus income forfeited by those who are economically successful. If we held the scales evenly on the high producers, concentration of wealth would not be less marked than it is to-day. It might be in different hands, but not the hands that are now held out to receive it in the form of charity. What, then, if the parasitic fraction of the population increases?

Not all the modern social trends are unsound as at present administered. Child-labour and compulsory-education laws are instances. The children who would be forced to labour if society permitted it come largely from stocks of low economic value. It might be argued, therefore, that the high death-rate resulting from the economic battle is desirable. Yet this is a sad method for reducing the percentage of undesirables. These children ought to have their chance in life along with other children, in spite of the wishes of capitalism and the church. And it so happens that the results of child-labour and compulsory-education legislation are more desirable from the evolutionary point of view than are the results of free competition. Child labour leads to a high birth-rate among people of the lower economic group. The children are a financial asset. Laws against the practice effect a reduction in the birth-rate. In fact, Karl Pearson found that after each new English law putting further limitations on child labour, the birth-rate showed a significant decline.

Unfortunately, the instances where current social reforms are genetically sound are rare. It is so difficult to frame laws dictated by a spirit of benevolence without at the same time putting society at the mercy of the ne'er-do-wells who wish to take advantage of that sentiment. The principle of the differential income tax no longer meets with serious objection from the wealthier classes. What they object to is the wasteful manner in which the revenues are expended, due in large part, no doubt, to the majority of the voters being exempt from a direct tax and lacking the brains to appreciate how great an indirect tax they pay. This difficulty might be remedied by requiring a small direct tax from every one, even though it cost more to collect it than it is worth. But how is it to be arranged at the same time not to penalise the good germ-plasm of the ambitious middle-class man who would like to raise a fair-sized family? The present system does not promote this worthy aim. It tends

to restrict the birth-rate in just the wrong place, and even to prevent the education of the small family now in vogue.

The particular way in which trade-unionism has developed is another case. No one now denies the numerous good points of the system. But why in the obsolete name of common sense is the output limited and the same wages given to the efficient and the inefficient workmen? Could a better plan be devised for breaking down ambition or for limiting the birth-rate of the ambitious and capable?

Again, consider old-age pensions. No one likes to imagine a society in which the citizen past his age of productive work must face discomfort or perhaps starvation. Let us, then, initiate a system of pensions. It cannot possibly be dysgenic, for the people we propose to care for have passed the reproductive age. Is this sound reasoning? Can we devise a system of old-age pensions which will not free the most undesirable families from all fear of the consequences of having innumerable children? Perhaps we can, but it is not so simple a matter as it seems at first sight.

And so it goes when one runs through the whole list of current social proposals. By far the great majority makes it possible for the irresponsible, the unintelligent, the wastrel, to exist in comfort and to reproduce his kind. The comfortable existence is all very well, the continuous reproduction is more serious.

It becomes a grave question whether the world should be remodelled entirely for the benefit of the moron. I do not know, for example, whether prohibition is a good thing or a bad thing. But it appears to have been installed chiefly in order to prevent the feebly inhibited from drinking themselves to death, and to enable them to raise larger families to maturity. It is certainly unnecessary for sensible men.

If the only thought is for the stupid, if every reform is designed to take care of the fool and to increase his numbers and his power, it follows that in the future the country will be given over to foolishness even to a greater extent

than it is at present. There will be a constantly growing demand for the suppression of art and literature, through the activities of benighted blockheads placed in posts of authority as censors. There will be further antievolution agitation. There will be an extension of such imbecile organisations as antivivisection societies, antivaccination societies, and the like. Science will be hounded, coerced, and suppressed, possibly destroyed. Let us not delude ourselves, us Americans. We have had incomparable natural advantages, and we have done reasonably well with our talents; but we have accomplished no miracles. The only matters upon which a nation is reasonably entitled to pride itself are accomplishments in art, literature, and science. And in proportion to our population, we have not equalled Switzerland, England, France, or Germany. Moreover, it is extremely dubious whether the trend of the quality of the work along these lines is upward. Obviously, it cannot improve if the quality of the population diminishes.

Not long ago the London *Spectator* awarded a prize for the best epigram on the "Modern World" to the following quatrain:

"Science finds out ingenious ways to kill
Strong men, and keep alive the weak and ill—
That these a sickly progeny may breed,
Too poor to tax, too numerous to feed."

It is an apt description of the current tone of social reform. Eight of every ten proposals promote the survival of the most undesirable members of society. It is also a fair hit at science, for science has made wholesale philanthropy possible. Yet let us be just. Science has also furnished the means of providing against increasing the flood of weak ones at the same time it has offered comfort to them as living beings.

The wisest humanitarian¹ of our time holds contraception to be the greatest discovery of the nineteenth century. He

¹ I refer here to Havelock Ellis.

is obviously correct. No other practical means exists to compensate for the dysgenic effects of broadly exercised benevolence; no other means exists for solving the problem of overpopulation without causing intolerable pain and sorrow. This is what that broad-visioned biologist, the late Professor Bateson, had in mind when he said: "It is in a decline in the birth-rate that the most promising omen exists for the happiness of future generations."

There are those who exhort the thinking portion of the population to compete with the thoughtless portion in the production of large families. In so far as such hortatory injunctions tend to prevent undue restriction of the birth-rate among the well endowed, there can be no objection to them. But preaching thus will not eliminate the differential birth-rate in favour of those least fitted to carry on to a higher civilisation. And besides, there is the lurking menace of a population density bringing about more wars, more sickness, and a higher death-rate to be considered.

Warren Thompson, the Director of the Scripps's Foundation for the Study of Population Problems, once remarked that if the better classes of the population continue to restrict their families, the answer of Nature is clear. She will say that they are unfit. "She shows clearly that she prefers the lower classes who live simply, who reproduce more or less instinctively, who do not think about the future of the race or of civilisation, but who are carrying the burden of the future in the rearing of children." I feel sure that Thompson did not say just what he intended here. Nature makes no such statements. Nature eliminates the unfit and preserves the fit—that is, the fit to survive. Her fool-killing devices were highly efficient in the olden days before civilisation came to thwart her. It is man, not Nature, who has caused all the trouble. He has put his whole soul to saving the unfit, and has timidly failed to do the other half of his duty by preventing them from perpetuating their traits.

The biologist's stand has been ridiculed by captious critics, who say he cannot define the unfit and the fit. Nonsense! The unfit are primarily the unintelligent, and secondarily the physically unsound. The fit, as Cattell¹ said years ago, are "men like William James and Francis Galton," men healthy in body and mind, intelligent men, original men, men with kindliness, liberality, nobility.

Genetics gives fair warning to the sensible but timid social worker, to the short-sighted physician, to the perverted Comstockian, and to the sophists of the church, that civilization is in a dangerous situation, for which only one remedy is specific. Devise proper methods for safeguarding its use, if you will. But see that it is used to reduce the survival of the unfit, or the next generation will hold you to account.

¹ J. M. Cattell. "Francis Galton." *Pop. Sci. Mon.*, March, 1911, p. 312.

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